CONCRETE
AND
CONSTRUCTIONAL ENGINEERING

OCTOBER, 1950. **Vol. XLV, No. 10**

FORTY-FIFTH YEAR OF PUBLICATION

PRICE 1s. 6d. ANNUAL SUBSCRIPTION 18s., POST FREE. $3.50 in Canada and U.S.A.

LEADING CONTENTS

	PAGE
Engineering and the Arts	345
Design and Construction of a Prestressed Concrete Arch Footbridge at Oxford. *By A. Goldstein, B.Sc.(Eng.)*	347
Rapid Concrete Construction in Spain. *By N. B. Bourne, M.A.*	357
Torsion in Continuous Structures. *By A. Chronowicz*	363
Book Reviews	366
Design of Deep Reinforced Concrete Beams and Blocks	367
Distributing Concrete at the Royal Festival Hall, Festival of Britain	373

No. 815 ISSUED MONTHLY *Registered for Canadian Magazine Post*

BOOKS ON CONCRETE For catalogue of "Concrete Series" books on concrete and allied subjects, send a postcard to:

CONCRETE PUBLICATIONS LTD., 14 DARTMOUTH ST., WESTMINSTER, S.W.1

For nearly 60 *years*

this trade mark has stood for speed and strength in reinforced concrete work.

DRAGON

(Brand)

PORTLAND CEMENT

Supplied by

THE SOUTH WALES PORTLAND CEMENT & LIME CO. LTD.

PENARTH, SOUTH WALES

Telephone : Penarth 300 Telegrams : "Cement, Penarth"

St. George's Hall, Liverpool, completed in 1854, provides a classic example of Greek architecture adapted to modern requirements.

It is perhaps fitting that the massive timber roof destroyed by fire in 1941 should have been replaced by one of steel fireproof construction and covered with Ruberoid Insulated Metal Roofing, the most effective of the modern roofing systems.

RUBEROID ROOFING

Photographs are reproduced by the courtesy of Ronald Bradbury, Ph.D., F.R.I.B.A., A.M.T.P.I., City Architect, Liverpool Corporation.

THE RUBEROID COMPANY LIMITED
16, COMMONWEALTH HOUSE
1-19 NEW OXFORD STREET, LONDON, W.C.1

Architects and Engineers are invited to write for the range of Ruberoid Technical Catalogues.

A

Bar Bending and Fixing

We can undertake prompt execution of all orders for this work. We can quote as follows, and will be glad to have your enquiries:—

Supply, Bend and Fix to specification.

Supply and Bend to specification.

Alternatively, customer's own material can be bent and fixed, or fixed only.

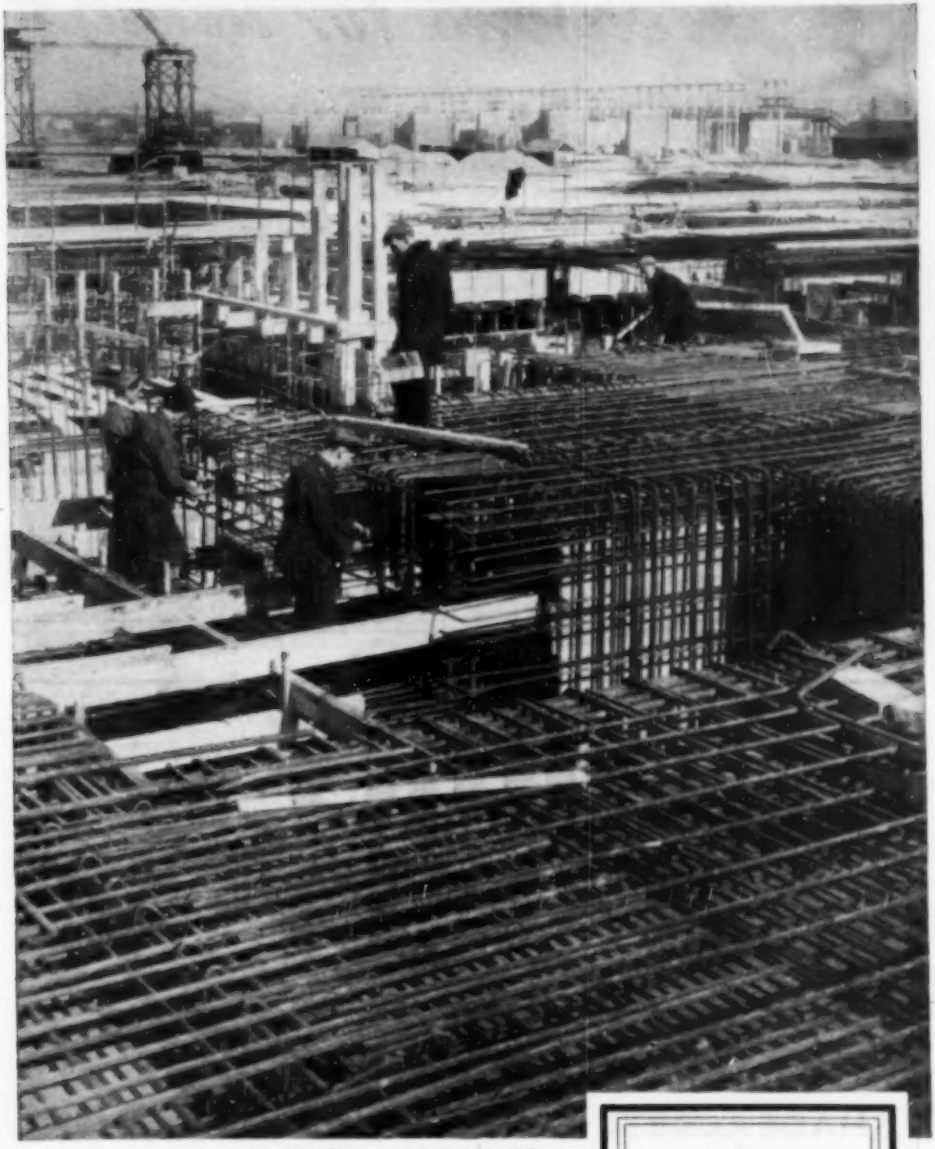
Whatever we do you can count on first class service from the most modern contractors in the trade. We can save you time, money and worry—usually all three; so if your next contract includes reinforcement, get in touch with us and let us tell you what we can do.

General Steel

BAR BENDING & FIXING DEPT.

GENERAL STEEL & IRON CO LTD · SPRINGFIELD RD · HAYES · MIDDLESEX

Telephone: SOUTHALL 3221



Consulting Engineers: W. S. Atkins & Partners

Construction of heavy reinforced concrete foundations for the Cold Reduction Plant at Abbey Works for the Steel Company of Wales Limited.

***John Laing and Son Limited** - Building and Civil Engineering Contractors, London, Carlisle, Lusaka, Johannesburg.*

LAING

8 reasons for using

DAREX AEA in concrete

It—

1. Enables water-cement ratio to be reduced.
2. Increases plasticity and improves workability.
3. Requires less spading or vibration.
4. Minimizes patching and rubbing.
5. Reduces "bleeding."
6. Is quicker to finish.
7. Gives better surface texture.
8. Is more durable and watertight.

Supplies now available, ask for information

DEWEY & ALMY LTD

ELVEDEN RD., PARK ROYAL, LONDON, N.W.10. Phone: ELGar 5671

COLOURS for ASPHALT!

Introducing a new range specially prepared for ASPHALT by the Manufacturers of the well-known

"SHADEACRETE" COLOURS FOR CEMENT

LET US SEND YOU SAMPLES AND PRICES OF

RED · BLUE · YELLOW · GREEN · BROWN

W. HAWLEY & SON, LTD.

Colour Works, **DUFFIELD**, Derby

Phone: Duffield 2294/5 **COLOUR MAKERS SINCE 1838** Grams: Hawley, Duffield

The first pre-stressed concrete road in Britain

Sponsored by the Crawley Development Corporation, this stretch of road has been laid down on modern principles of prestressed construction and will be carrying heavy traffic serving the factory estate of the Crawley New Town.

Note the diagonally arranged steel ducts which house the high-tensile steel cables spanning the road at an angle of 18½° at 7' 6" centres. The whole has been laid over SISALKRAFT Reinforced Waterproof Concreting (Subsoil) Paper.

Observe also the SISALKRAFT Prefabricated Concrete Curing Blankets specified and used throughout for the curing and protection of this brief but unique highway.

Photograph by kind permission of Crawley Development Corporation (Chief Engineer: A. J. W. McIntosh, Esq., B.Sc., M.I.C.E., M.I.Mech.E.), Broadfield, Crawley, Sussex. Contractors: Messrs. Willment Bros., Ltd.

★ TECHNICAL INFORMATION AND SAMPLES ON REQUEST

Sole Distributors for British Sisalkraft Ltd.

J. H. SANKEY & SON, Ltd.

Such Structures Suggest

SISALKRAFT TRADE MARK

THE Building Paper

ALDWYCH HOUSE, ALDWYCH, LONDON, W.C.2. Telephone: Holborn 6949. Telegrams: Brickwork, Estrand, London

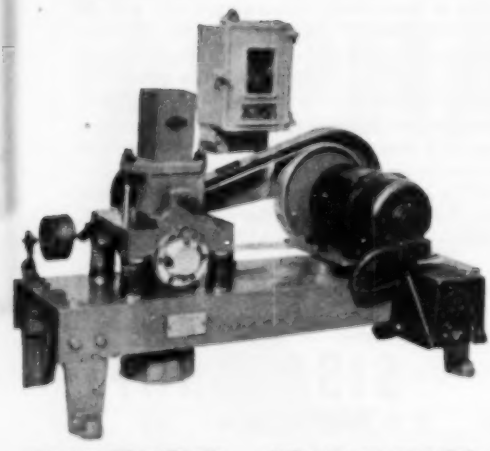
BUILDING AND CIVIL ENGINEERING
REINFORCED AND PRESTRESSED CONCRETE

DOUGLAS

PILING · HEAVY FOUNDATIONS · ROADS · BRIDGES · AIRFIELDS
FACTORIES · SEWERS · RAILWAYS · BUNKERS · COFFERDAMS

ROBERT M. DOUGLAS (CONTRACTORS) LTD.
395 GEORGE ROAD, BIRMINGHAM, 23 Telephone : Birchfields 4541

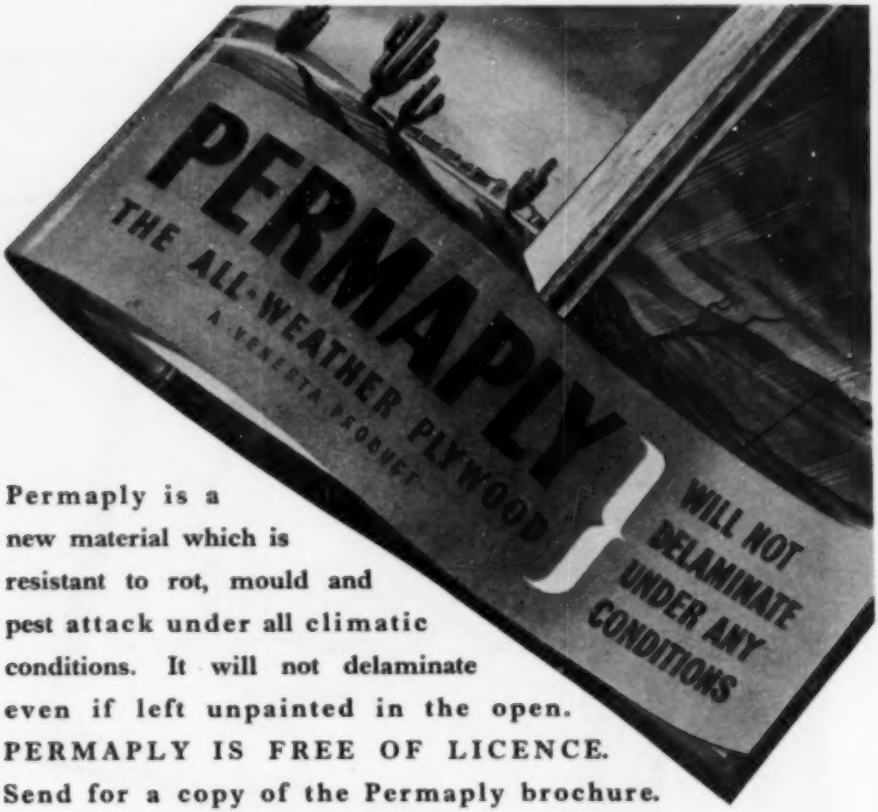
"CAPCO" H. F. VIBRATOR



for compacting mortar cubes for Compression Test B.S. 12/1947, B.S. 915/1947, B.S. 146/1947, B.S. 1370/1947 with automatic time control device. The vibrator illustrated in the B.S. was built in our works.

The "CAPCO" range of concrete testing apparatus also includes Cube Moulds; Slump Cones; Tensile, Vicat, and Cylindrical Moulds; Tile Abrasion Machines; Compacting Factor Apparatus.
Full details on request.

CAPCO (SALES), LTD. (Sole Agents for all "Capco" Products)
BEACONSFIELD ROAD, LONDON, N.W.10. Telephone: WILLESDEN 6067-8. Cables: CAPLINKO, LONDON



Permaply is a new material which is resistant to rot, mould and pest attack under all climatic conditions. It will not delaminate even if left unpainted in the open.
PERMAPLY IS FREE OF LICENCE.
Send for a copy of the Permaply brochure.

PERMAPLY . . . *a Venesta product*

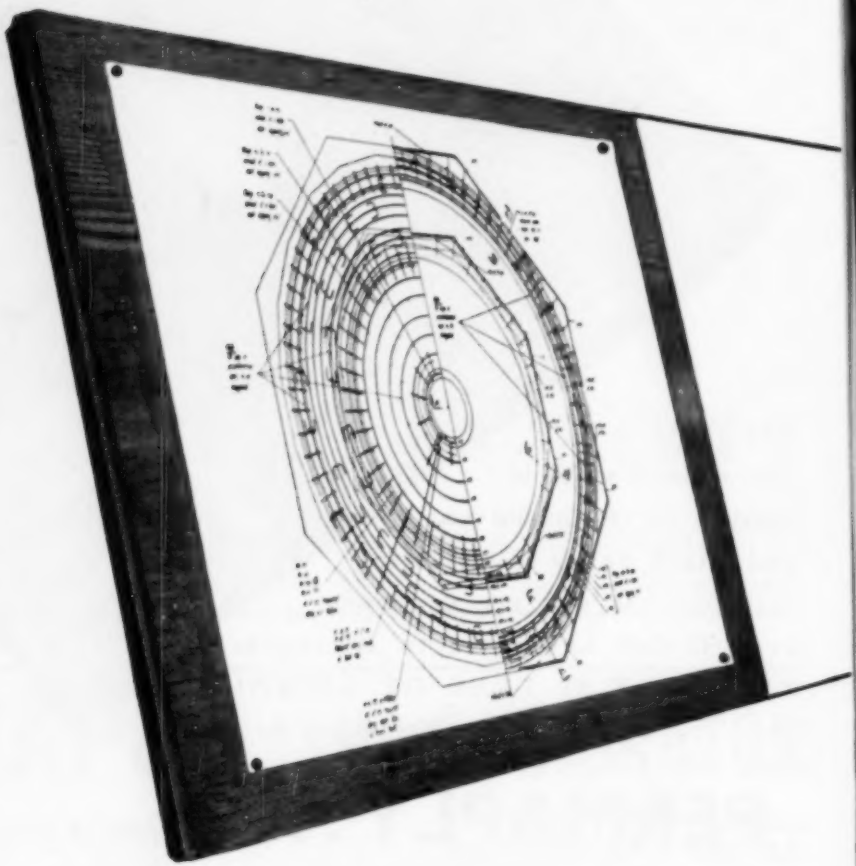
FOR CONCRETE SHUTTERING

- **Permaply puts the perfect Face on concrete.**
- **Is light, flexible and durable.**
- **Has a long life and has been re-used for as many as 200 times.**

VENESTA LIMITED

VINTRY HOUSE · QUEEN STREET PLACE · LONDON · E.C.4 Tel. CENtral 3060

T175-181



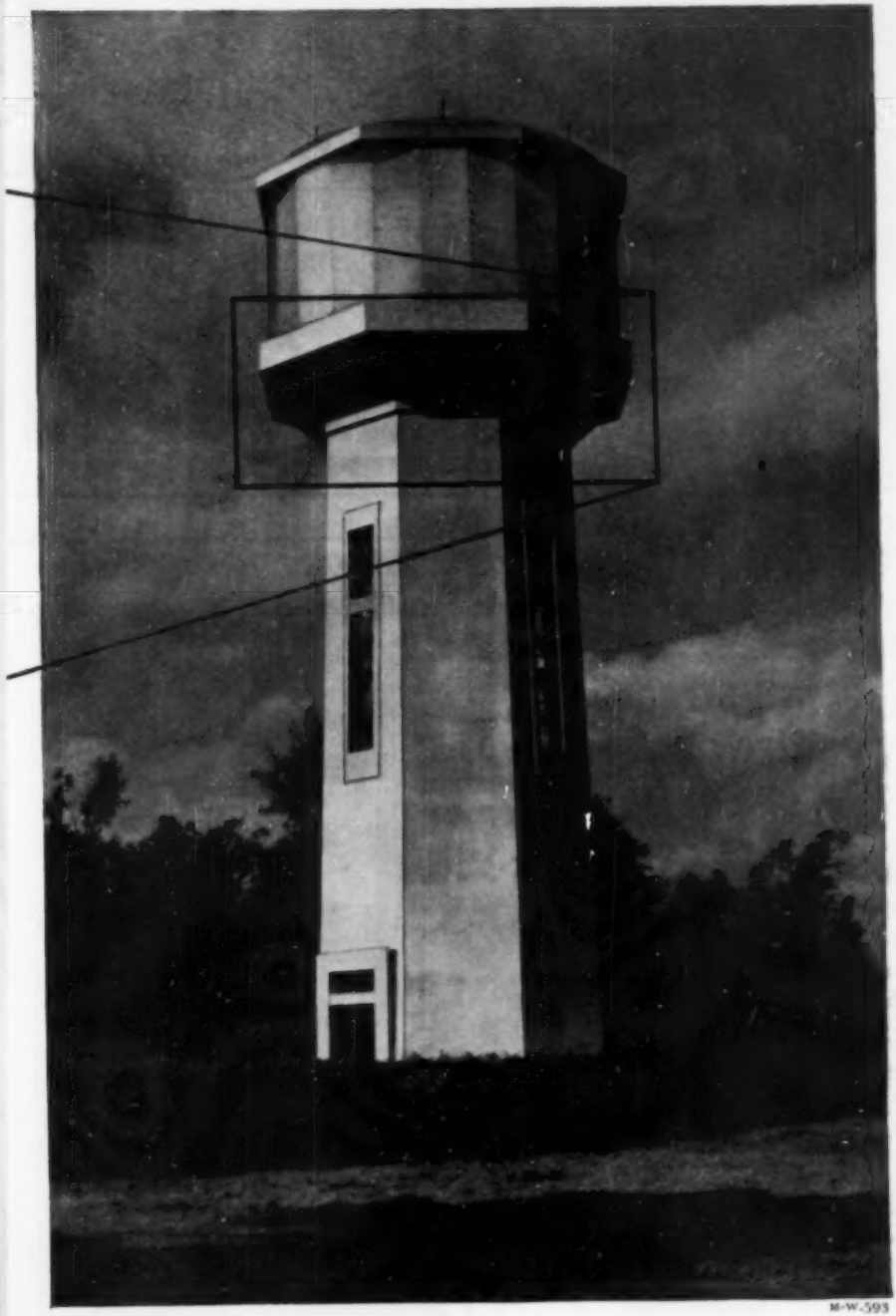
BRC

brings the accuracy of
the drawing board to the job

Issued by THE BRITISH REINFORCED CONCRETE ENGINEERING CO. LTD., STAFFORD

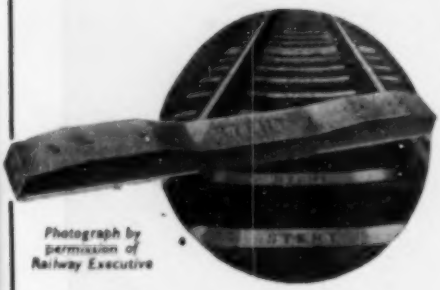
Specialists in Reinforced Concrete Design & Suppliers of Reinforcement

London, Birmingham, Bristol, Leeds, Leicester, Manchester, Newcastle, Sheffield, Cardiff, Glasgow, Dublin, Belfast



M-W.593

For a REALLY Permanent Way —



Photograph by permission of Railway Executive

CONCRETE SLEEPERS

British Patents Nos. 569573–16779/43
and Patented in other countries

★ pre-stressed positive anchorage

a logical modern development by **STENT**

STENT PRECAST CONCRETE LTD.

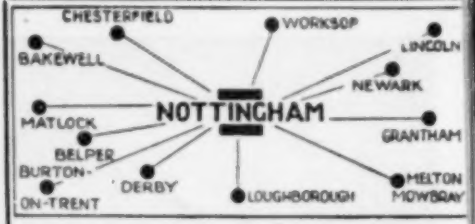
Sales: 1, Victoria St., London, S.W.1
Telephone: Whitehall 2573

Works: Dagenham Dock, Essex
Telephone: Rainham (Essex) 780

Agents for Wales and South-West England: T. L. LOWE, Esq., B.Sc.Eng., A.M.I.C.E., M.Inst.M.E.; DAVIES, MIDDLETON & DAVIES, LTD., 9, Museum Place, CARDIFF. *Telephone*: Cardiff 2370/1.

Midland Agent: FABIAN J. M. JACKSON, M.In.B.E., M.I.Pl.E., 11, Leicester Rd., LOUGHBOROUGH. *Telephone*: Loughborough 3781 & 3543. 56, St. Mary's Rd., MANCHESTER, 10. *Telephone*: FAl 2623.

L295B

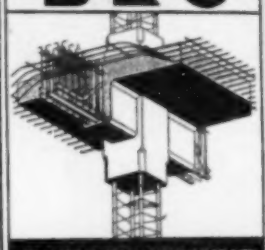


Trent Gravels
10,000 tons per week
Washed & Crushed 1½ in. to ¼ in.

We are the leading suppliers of high-class concrete aggregates in the area shown above. Prompt deliveries guaranteed and keen competitive prices quoted. Send for samples and prices.

TRENT GRAVELS LTD
ATTENBOROUGH NOTTS
Telephone: Beeston 54255.

BRC

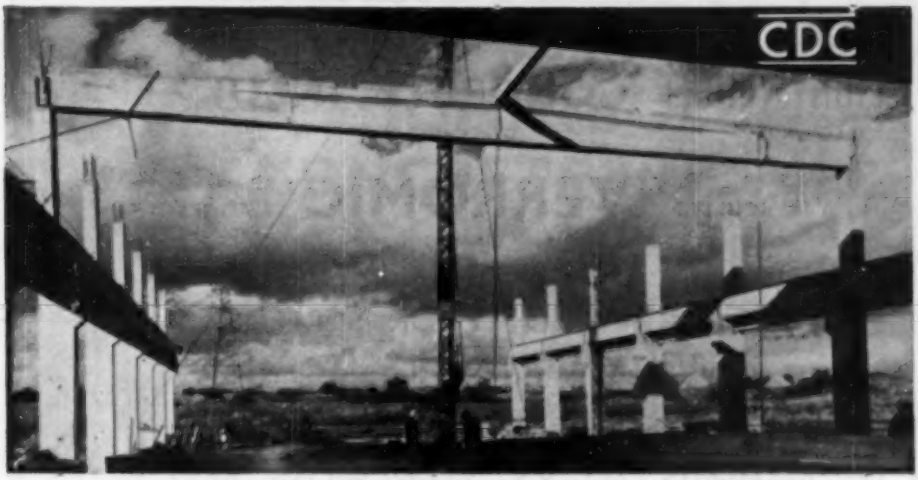


REINFORCEMENT

BOOKS ON CONCRETE
"CONCRETE SERIES"

books on concrete are available on practically every aspect of the design and construction of reinforced concrete and precast concrete, the manufacture and chemistry of cement, and kindred subjects. For a complete catalogue giving prices in sterling and dollars, send a postcard to:

CONCRETE PUBLICATIONS, Ltd.
14 Dartmouth St., London, S.W.1
England



PRESTRESSED CONCRETE BEAMS

The advantages of using prestressed, precast beams are:

1. REDUCED CROSS-SECTION 2. LOW INITIAL COST 3. LOW ERECTION COST

Shown above is a 55-ft. span I-section saddle-back roof beam of 12-in. width in course of erection. These beams have a depth-span ratio of 1 to 22. CDC Ltd. *manufacture prestressed, precast piles, beams, trestles, poles and floor units.*

CONCRETE DEVELOPMENT CO. LTD

Office & Works: THORNEY LANE, IVER, BUCKS. *Telephone:* IVER 809

Line of route delivery

Water, gas and electricity installation or renewal schemes need good transport co-operation and British Railways can supply it. They convey and deliver on line of route, cables, conduit covers and pipes, besides bricks, cement and kindred commodities. Bulk deliveries of road dressing materials are made to site, including barrels, which are collected after use. Storage for contractors' tools and materials is available at central railheads. A word to your local Goods Agent will set the wheels turning.

BRITISH RAILWAYS

FOR

LIGHTWEIGHT **CONCRETE INSULATION**

SPECIFY

VERMICULITE **"VERROMIC"** AGGREGATES

(BRAND)

FOR

ROOF AND FLOOR SCREEDS.
BARREL VAULT ROOFS—FLAT ROOFS
RADIANT HEAT FLOORS
AND
ENCASEMENTS TO R.S. STANCHIONS AND BEAMS

VERMICULITE INSULATING CO., LTD.
SWINTON HOUSE, 324 GRAY'S INN ROAD, LONDON, W.C.1
Telephone: Terminus 9674, 9675
Also at **81 EDMUND ST., BIRMINGHAM. 3 & 164 WEST GEORGE ST., GLASGOW, C.2**

ENGINEERS SPECIFY THEM because reinforcement is securely fixed without fear of displacement by rough usage, tamping, or vibration. No snipped ends are left to cause rust marks.

CONTRACTORS PREFER THEM because they are cheaper and fixed more easily and quickly than any other type. Test them on your next contract at our expense.

. . . **SAVE TIME, LABOUR & MATERIALS**

I.S.E.G.

I.S.&G. MERCHANTS LTD.
(Formerly EDWARD LE BAS & CO., LTD.)

14 FINSBURY CIRCUS, LONDON, E.C.2
'Phone: London Wall 6805.
'Grams: Gramercy, London.

THE

"JOHN BULL" CONCRETE BREAKER

NEW "B.A.L." TYPE.

INCREASED :—

PENETRATION, RELIABILITY, LIFE.

REDUCED :—

VIBRATION, NOISE AND WEAR.

THESE ARE THE SALIENT FEATURES OF THE NEW CONCRETE BREAKER

★ ★ ★

REAVELL & CO., LTD.

RANELAGH WORKS, IPSWICH.

TELEGRAMS: "REAVELL, IPSWICH." TELEPHONE: 2124

dustless floors

Concrete dust is fatal to machinery, a severe inconvenience to operatives and a constant menace to production.

"CCC CASEHARDENING" process produces a floor which is not only hard—*so hard that even by the drastic use of a wire scratch broom no concrete dust can be raised*—but is also impervious to water and resistant to the destructive action of oils, grease and soda.

"CCC Casehardening" process is applied only by our trained staff and the result is guaranteed.

"CCC" PREMIX for Waterproofing, Rapid Hardening, and Toughening Concrete

CONCRETE CASEHARDENING CO. LTD

CRESCENT WHARF · BIRMINGHAM · 1

L.G.B.

SUPER CEMENT

'SUBMARINE' BRAND

THE TANNO-CATALYSED PORTLAND CEMENT

SAVES TIME **SAVES TROUBLE**

NATURALLY WATERPROOF. CONTAINS NO WATER REPELLENT MATERIAL

Uses:—

For CONCRETE
Provides a CONCRETE of great strength at early dates and impervious to water, oil, etc., without any form of surface coating.

For PAVING
Produces a hard wearing PAVING, dustless and proof against penetration by water, etc.

For RENDERING
Supplies an impenetrable RENDERING of such adhesive power that a 1" thickness will resist an outside pressure of at least a 20' head of water.

For SLURRY (as paint)
Makes a perfectly watertight covering to brick or breeze concrete walls at very small cost, and also provides the best watertight undercoat to coloured finishes.

Technical information is available to users.

Used in 1914-1918 and still used by:

Air Ministry, War Office, Admiralty, Ministry of Works, Ministry of Supply, etc.

SUPER CEMENT LTD., 29 TAVISTOCK SQUARE, LONDON, W.C.1 *Phone: Euston 1808*

THE LEEDS OIL & GREASE CO. · CHADWICK ST. LEEDS ·

CONCRETE MOULD OIL

PIN YOUR FAITH TO THE TESTED BRAND.

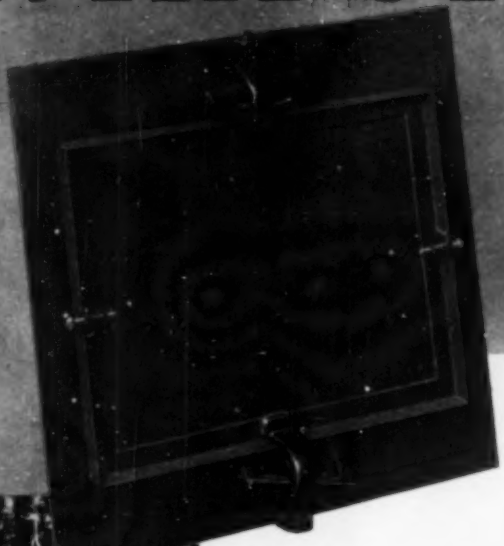
THIS LABEL ON EVERY BARREL CARRIES WITH IT FORTY YEARS' EXPERIENCE OF MANUFACTURE.

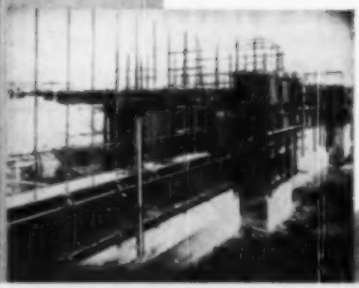
NONE OTHER IS "JUST AS GOOD"

THE LEEDS OIL & GREASE CO.

'Phone: 22480. LEEDS 'Grams: "Grease."

KWIKFORM





. . . the adaptable concrete formwork

Service tunnel constructed with standard formwork.

Foundation works for large Midland Iron Works.

is designed to meet the widest possible variety of uses: Double or Single Face work; Columns; Beams; Piers; Battered retaining walls, etc.

Patents granted or pending in all principal countries of the world.

Descriptive schedule No. 2599 with terms for hire or purchase will be sent on request.

KWIKFORM LTD., WATERLOO RD., BIRMINGHAM 25. *London Office: 66 Victoria St., S.W.1*

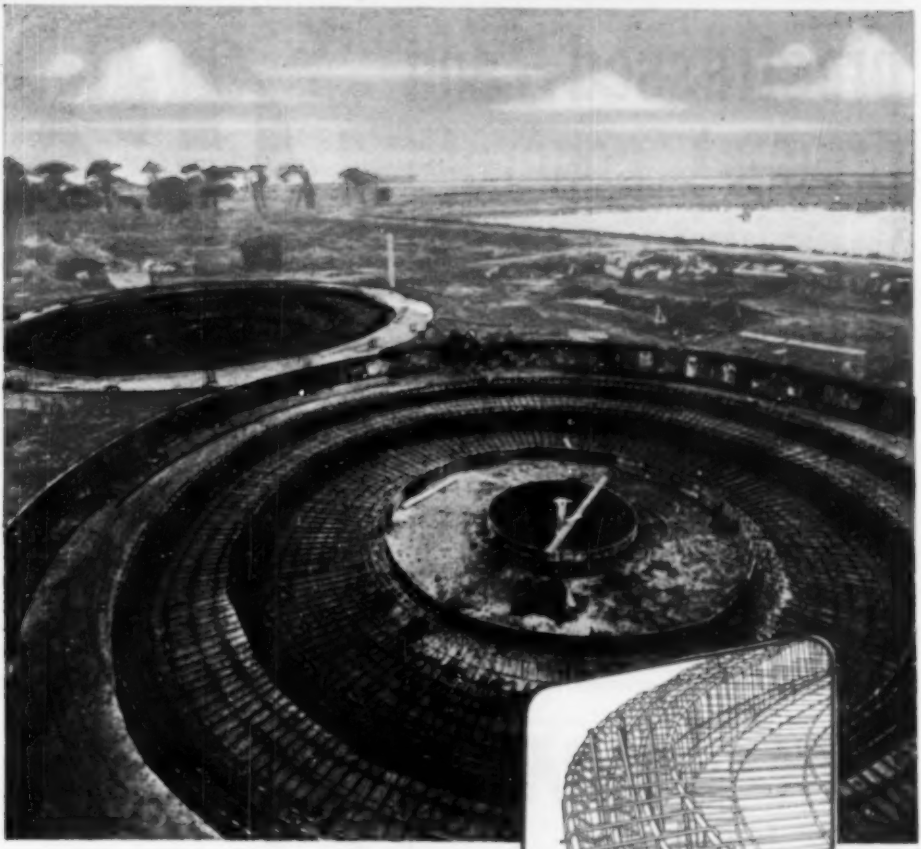
L.G.B.

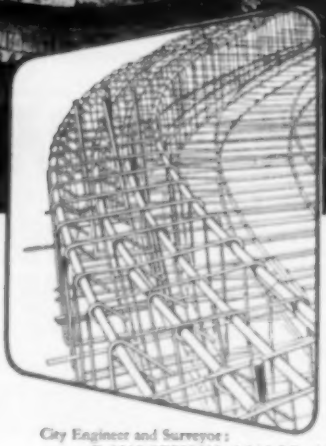
ALPHA CEMENT LTD

PORTLAND HOUSE, TOTHILL STREET

LONDON, S.W.1.

Telephone - Abbey 3456.





REINFORCEMENT

for all ferro-concrete work

The illustration shows reinforcement work in course of construction for two circular sedimentation tanks which form a part of the City of Hereford New Sewage Scheme. The whole of this reinforcement was supplied, bent and fixed by T. C. Jones & Co., Ltd.

City Engineer and Surveyor:
F. MARGERISON, A.M.I.C.E., M.I.Mun.E., M.I.W.E.

Consulting Engineers:
MESSRS. L. G. MOUCHEL & PARTNERS, LTD.

Main Contractors:
MESSRS. M. J. GLEESON, LTD.

T.C.Jones & Co.Ltd 600 GROUP

STRUCTURAL & REINFORCEMENT ENGINEERS

A complete service is available for the design, supply, bending and fixing of steel reinforcements

WOOD LANE, LONDON, W.12. *Telephone: Shepherds Bush 2020* · **BUTE STREET, CARDIFF · TREORCHY, GLAM.**

CCE/505/TR7

prestressed and precast concrete for building and civil engineering

A symbol of quality materials, experienced workmanship, expert supervision and excellent service.

We specialise in the production of prestressed and precast concrete structural members to standard or special designs, including railway sleepers, and shall be pleased to submit quotations for contracts in most parts of the country.

H. B. CONCRETE CO LTD

Head Office : East Street, Epsom, Surrey.
Telephone : Epsom 4041/4042.

Branch Works : Vicarage Road, Egham, Surrey.
Telephone : Egham 3092/3093.

When CORROSION wins – you lose!

—to leave walls, floors, tanks, pits, pipes, channels, etc., unprotected against the attacks of Acid, Alkali, Oil or Water, is to expose them to rapid deterioration, and continual maintenance costs.

Windsors provide a complete range of products for the protection of Wood, Metal, Concrete, Brickwork, etc.

Call WINDSORS today – keep Corrosion away

H.WINDSOR & Co LTD

748, FULHAM ROAD, LONDON, S.W.6 'Phone : RENown 6006-7-8.

119, VICTORIA STREET, LONDON, S.W.1 'Phone : VICtoria 9331/2.

ALLAM

VIBRATING EQUIPMENT for QUALITY CONCRETE

PETROL & ELECTRIC VIBRATING TAMPERS

SALE OR HIRE

Details of these and other vibrating plant sent on application.

Manufacturers of vibrating tables, internal vibrators, external vibrators, petrol and electric vibrating tampers, vibrating screens, pan vibrators, electric motors, petrol engines, builders' hoists and winches, and hydraulic bar croppers.

E. P. ALLAM & CO. LTD.

LONDON : 45 Great Peter Street, S.W.1. *Telephone :* Abbey 6353 (5 lines)

SCOTLAND : 30 Cavendish St., Glasgow, C.5. *Tel. : South* 0166. Works : Eastwood, Southend-on-Sea. *Tel. : Eastwood* 50243

REINFORCED CONCRETE by

A. G. MANSELL & CO. LTD

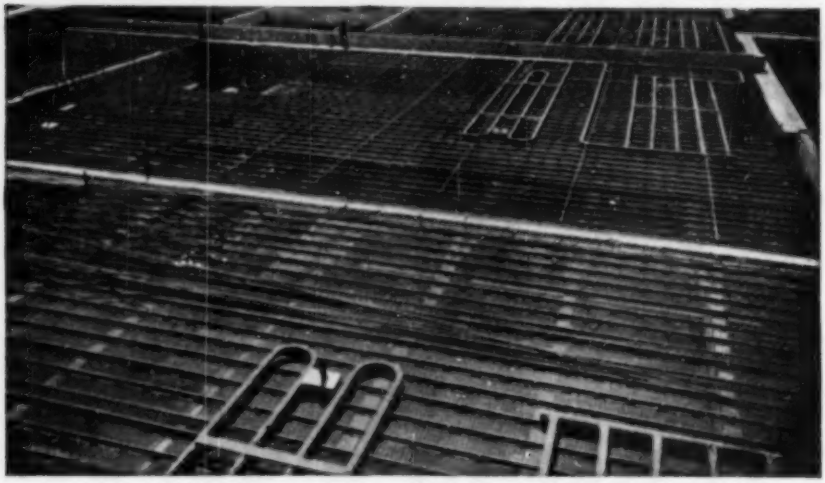
CIVIL ENGINEERING AND BUILDING CONTRACTORS

BRIDGES - RIVER AND SEA DEFENCE WORKS - WATER TOWERS - BUNKERS
SILOS - INDUSTRIAL BUILDINGS - ROADS - FOUNDATIONS - AND PILING.

78 BUCKINGHAM GATE, LONDON, S.W.1. TELEPHONE : WHITEHALL 8735-6-7.

Houses at Bath Road, Southsea. Super "Ribmet" used for the concrete floors. Architect: Mr. A. G. Goodair, A.R.I.B.A., Southsea. Builder: Mr. E. B. Greenwood, Southsea.

COMBINED SHUTTERING & REINFORCEMENT?



LET EXPANDED METAL DO THE JOB!

As a combined shuttering and reinforcement for spans up to 15 ft. Super "Ribmet" is efficient and economical in the construction of concrete floors, roofs and similar decking. Its use gives the advantages of monolithic construction without the expense of preparing, erecting and dismantling close-boarded shuttering. No waste of steel because Super "Ribmet" replaces reinforcing rods and fabric.

Super "Ribmet" is 'made to fit the job' and complete technical information to suit your requirements will be supplied, upon request.

The EXPANDED METAL COMPANY LTD.,
Burwood House, Caxton St., S.W.1
WHitehall 1736

STRANTON WORKS, WEST HARTLEPOOL. HARTLEPOOLS 2194

ALSO AT: ABERDEEN, BELFAST, BIRMINGHAM, CAMBRIDGE, CARDIFF, EXETER, GLASGOW, LEEDS, MANCHESTER.

EXPANDED METAL

'Expamet'

PRODUCTS

SINEX VIBRATORS for CONCRETE ROADS and STRUCTURES

Sinex Electric Vibrators of the pin fixing type are used for compacting concrete roads and structures all over the world. They are extremely simple to attach to any road tamper by means of an eccentric pin and bracket, and can be utilised for shutter vibration by this same method of attachment.

Sinex Vibrators can be supplied for any A.C. voltage required, and where an electric supply is not available we can provide Petrol Electric Generators suitably wound.

Our illustrations show two typical examples of the uses of these Multi-Purpose Machines.

SINEX ELECTRIC IMMERSION VIBRATOR

This illustration shows a Sinex 80-watt electric vibrator mounted on a rigid steel lever for use in immersion vibration. This method was used very largely on the Mulberry Harbour and has since been adopted at various contracts in this country and abroad, and is universally accepted where shutter vibration is not required.

SINEX SURFACE TAMPER

Illustration shows Sinex pin fixing Vibrator mounted on Surface Tamper. Vibrators can be supplied separately for fixing on to tampers constructed by the contractor or tampers can be supplied complete to customer's specification. Generators can also be supplied when electric supply is not available.

Our Technical Representatives will be pleased to call to discuss any concrete placing problems.

CONCRETE VIBRATION LIMITED

2 CAXTON STREET, WESTMINSTER, S.W.1 **Tel.: VIC 7503/5**

STONE COURT ★ AGGREGATES

General View of Plant at Rickmansworth.

ONE OF OUR MODERN CONCRETE AGGREGATES PLANTS

High-grade concrete aggregates graded to any specification, and the most punctual delivery service in England, can now be given to all Contractors, Builders, and Municipal Authorities carrying out concrete work and road construction in London and Suburbs and the Home Counties.

Washed all-in Ballast 2 in. down.

¾ in. Washed & Crushed or Uncrushed Shingle.

½ in. Washed & Crushed or Uncrushed Shingle.

Washed Pit Sand.

Soft Sand.

$\frac{1}{16}$ in. Crushed Grit.

STONE COURT BALLAST CO. LTD.

PORTLAND HOUSE, TOTHILL ST., WESTMINSTER, S.W.1

Telephone: Abbey 3456.

"...The best worker we have ever employed"

says
Mr. G. H. Millward
of the Bear Hotel
Evesham, Worcestershire

In a letter asking for a spare part for his Petter engine "of rather ancient vintage" Mr. Millward had this to say :

"I feel I must say a few words in praise of our little Petter engine. Would you believe it possible for it to work quite efficiently with the exhaust port so blocked with carbon that only a ¼ in. hole remained, with as much water as oil in the oilers, with a high percentage of water and rust in the petrol tank and carburettor, after being frozen time and time again absolutely solid, left out in all weathers, never put in a shed, never had new plugs since as far back as I can remember, and she still 'honks' away as good as new. She's the best worker we have ever employed."

Petters engines built today are just as reliable, but they are now backed by the most efficient Service organisation in the country. That is why you should always SPECIFY PETTER.

Petter

—THE **POWER** ON THE LAND
—THE **DRIVE** IN INDUSTRY
—THE **SERVICE** THAT SPANS THE WORLD

PETTERS LIMITED

Small Engine Division, Causeway Works, Staines, Middlesex. Tel.: Staines 1122

One of the **A**SSOCIATED **B**RITISH **O**IL **E**NGINES GROUP

A.45

INSEPARABLE

" Rome was not built in a day," but in due course these intrepid twins laid the foundations of the Eternal City . . . or so the legend runs.

Nowadays the construction of foundations is no legend. It is a coldly calculated science, and the choice of the piles upon which a building is to be carried marks the first of an Engineer's problems.

Not so much of a problem, however, when it is remembered that the Franki system of cast-in-situ piling has achieved distinction in every country and continent as the surest, safest and most economical of all methods. " Franki Piles carry more tons per pile " is an axiom known by Architects and Consulting Engineers alike. Thus the word **FRANKIPILE** has naturally emerged—a word which stands for the largest piling contract ever undertaken in the world.

FRANKI and PILES

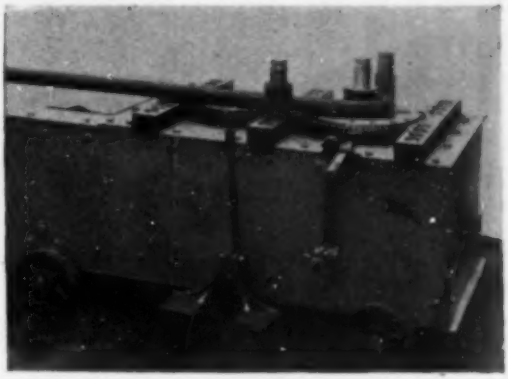
THE FRANKI COMPRESSED PILE COMPANY LIMITED
39 VICTORIA STREET, LONDON, S.W.1
Telephone: ABBey 6006-9
Telegrams: FRANKIPILE, SOWEST, LONDON

SOUTH AFRICA: THE FRANKI PILE CO. of S.A. (Pty.) LTD., CAPE TOWN and DURBAN

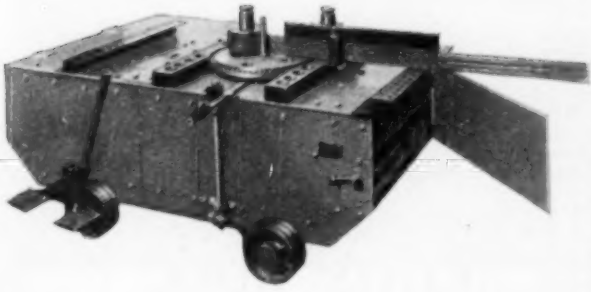
POWER BAR BENDERS
FOR ALL SIZES OF
REINFORCING BARS

STANDARD PRODUCTION MODELS

The ARD. 50 MODEL—as illustrated on right—has a capacity for cold bending Mild Steel Bars up to 2" dia. and incorporates a second Bending Head to give high rate bending for small diameter bars. The RAS. 40 MODEL shown below is a single disc machine of exceptional performance. With a capacity for 1¼" dia. bars, it bends at highest practical rate—e.g. a full hook takes only 3 seconds bending time.



Ensure accuracy, economy & simplicity of operation



INTERESTING FEATURES

Either of the Models illustrated can be supplied motorised, or engine driven.

Standard Accessories supplied include all necessary Formers and Bending Pins, a special Backrest for simultaneous bending of a number of small diameter bars and Accessories for forming right angle loops in one operation.

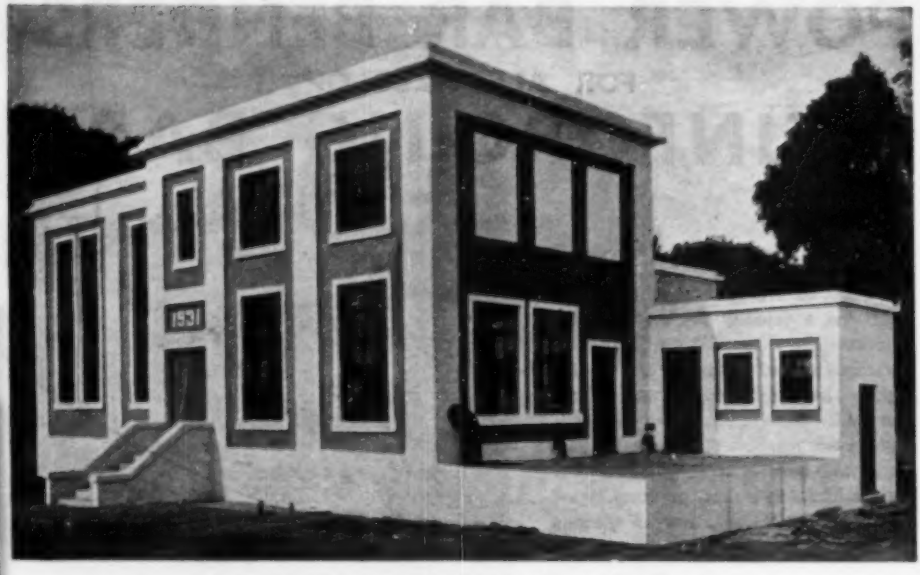
Special Safety Device incorporated to prevent damage to mechanism if overloaded.

The desired Bending Angle may be set mathematically, and this is of great assistance in "Repetition Bending".

CEMENT & STEEL LTD.

SECOND AVENUE CHATHAM KENT

Telephone: Chatham 45580 *Telegrams and Cables: Cembelgi, Chatham*



Candy Filter House for South-West Suburban Water Company.
Mr. H. Austin Palmer, Engineer.

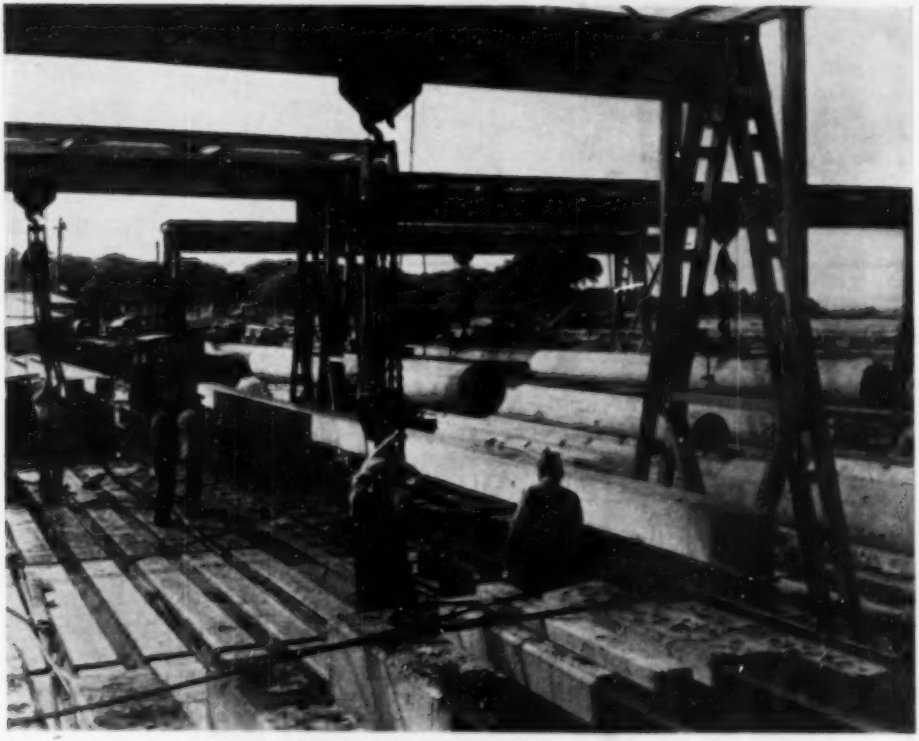
THE BEST WAY to illustrate CONCRETE
is by HALF-TONE BLOCKS
OF THE HIGHEST QUALITY

Complete Service of
ENGRAVING, TYPESETTING,
PHOTOGRAPHY,
ELECTROTYPING and STEREO-
TYPING and ARTISTS' WORK

THE STRAND ENGRAVING COMPANY LIMITED
8 & 9 ESSEX STREET, STRAND, W.C.2
Telephone: Temple Bar 6311. *Engravers to "Concrete."*

CHRISTIANI & NIELSEN LTD

REINFORCED CONCRETE



Reinforced Concrete Piles for Jetty

54 VICTORIA STREET, LONDON, S.W.1

TELEPHONE: VICTORIA 6152

SEALOCRETE and SEALANTONE

Make Cement or Concrete what it should be

* CASE HARDENED
* WATERPROOF
* DUST PROOF
* COLOURFUL

INFORMATION SHEET ON
SEALOCRETE METALLIC HARDENER
FOR PRODUCING
CASE HARDENED, HEAVY DUTY, DUSTLESS, WATERPROOF FLOORS
WHAT IT IS Specially ground and graded metallic substance, free from non-ferrous compounds.
WHAT IT DOES Gives Case Hardened, Hard Wearing Waterproof, Dustless surface to granolithic floors.
WHAT TO USE IT IN Floors of Bakeries, Breweries, Canneries, Factories, Warehouses, Dock Buildings, Harbours, Foundries, Power Stations, etc.
HOW TO USE IT Mix with dry cement, finally adding granite aggregates and water.
Lay on in usual manner for granite floors. In cases of heavy duty floors, we suggest this material be dusted on the face of the new cement work immediately it has been placed and levelled, in addition to incorporating it throughout the final thickness of granite topping.

Manufactured by :— *For further particulars write to :—*

SEALOCRETE PRODUCTS LTD., ATLANTIC WORKS, MACBETH ST., LONDON. W.6

Tel. : RIVerside 2686, 2687 & 7275. Telegrams and Cables : "EXPLOITURE, LONDON."

A. E. FARR, LTD.

Station Road - WESTBURY - Wilts.

'Phone: WESTBURY (Wilts) 256 (5 lines)

and

2 Victoria Street, WESTMINSTER, S.W.1

'Phone: ABBEY 2008 (2 lines)

CIVIL ENGINEERING AND BUILDING CONTRACTORS

DEPARTMENTS:

1. CIVIL ENGINEERING.
   - Earth Moving and Levelling.
   - Pile Driving and Heavy Foundations.
   - Road and Bridge Building.
   - Sewers and Water Mains.
   - Tunnels and Outfalls.
   - Reservoirs and Water Towers.
   - Cooling Towers, Chimneys and Silos.
   - Wharves and Jetties.
   - Railway Sidings, etc.

2. BUILDING.
   - Factories, Offices, Schools, Garages, etc.

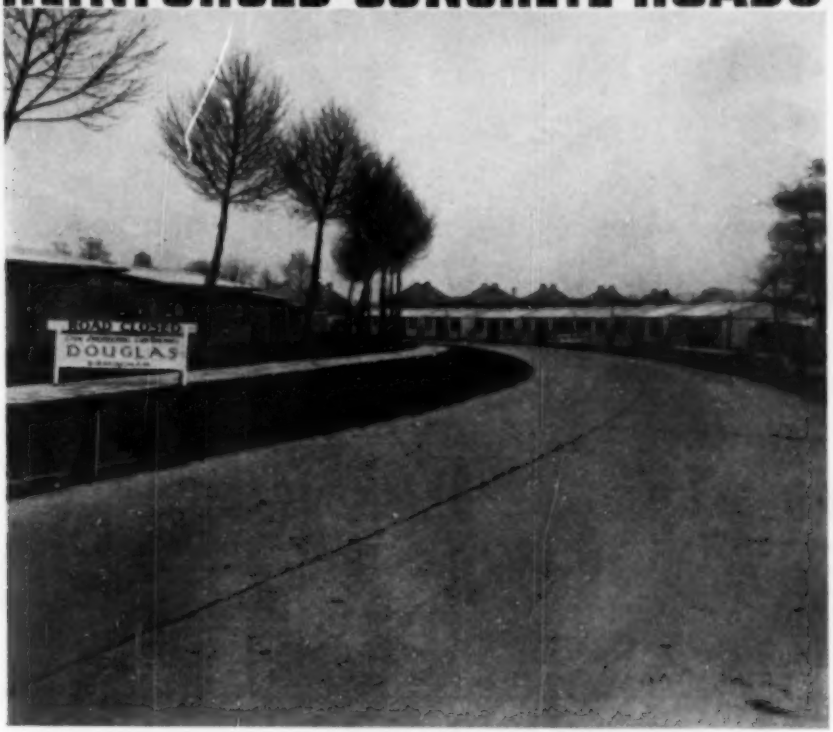
3. PLANT HIRE.
   - Excavators, Trenchers.
   - Bulldozers, Scrapers.
   - Dumpers, Rollers.
   - Compressors, Mixers.
   - Concrete Pumps.
   - Pile Frames.
   - Winches and Hammers.
   - Mobile Cranes, etc.

4. HEAVY HAULAGE.

Special Machinery Carriers and Low-Loading Lorries for carrying heavy plant and machinery up to 30 tons weight.

Dismantling and erection of heavy machinery undertaken.

REINFORCED CONCRETE ROADS



CHEAPEST IN THE LONG RUN WITH . . . .

Reinforcement BY McCALLS

"Matobar" welded steel fabric reinforcement was used in the laying of Queen's Road, Yardley, nr. Birmingham—the site shown in the photograph.

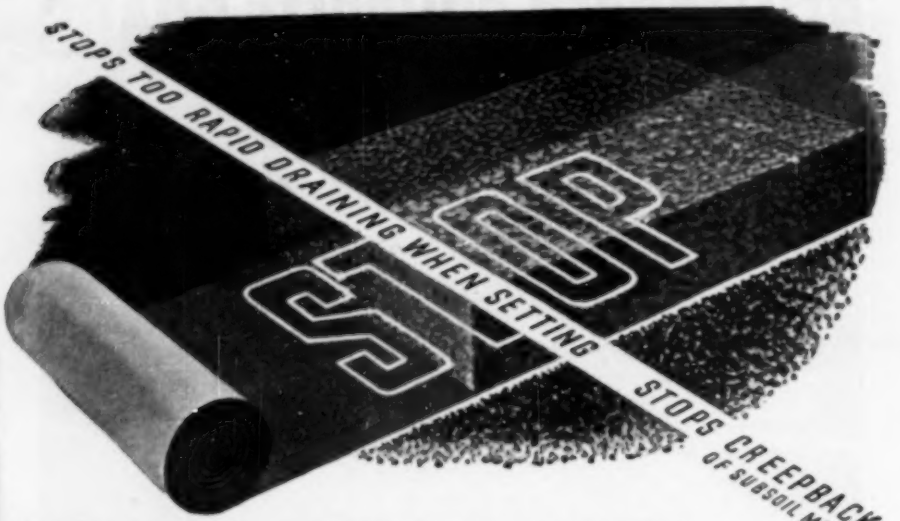
Engineer: H. J. Manzoni, C.B.E., M.Inst.C.E., City Engineer and Surveyor, Birmingham.

Contractors: Robert M. Douglas (Contractors), Ltd., Birmingham.

McCALL AND COMPANY (SHEFFIELD) LIMITED

TEMPLEBOROUGH · SHEFFIELD · AND AT LONDON

SRB.20



ANDERSON'S CONCRETING PAPER

gives 100% protection to concrete road foundations. It prevents the water from leaving the concrete before it is properly hardened, and insulates the foundation and reinforcement against moisture and impurities in the subsoil. Send for samples and particulars.

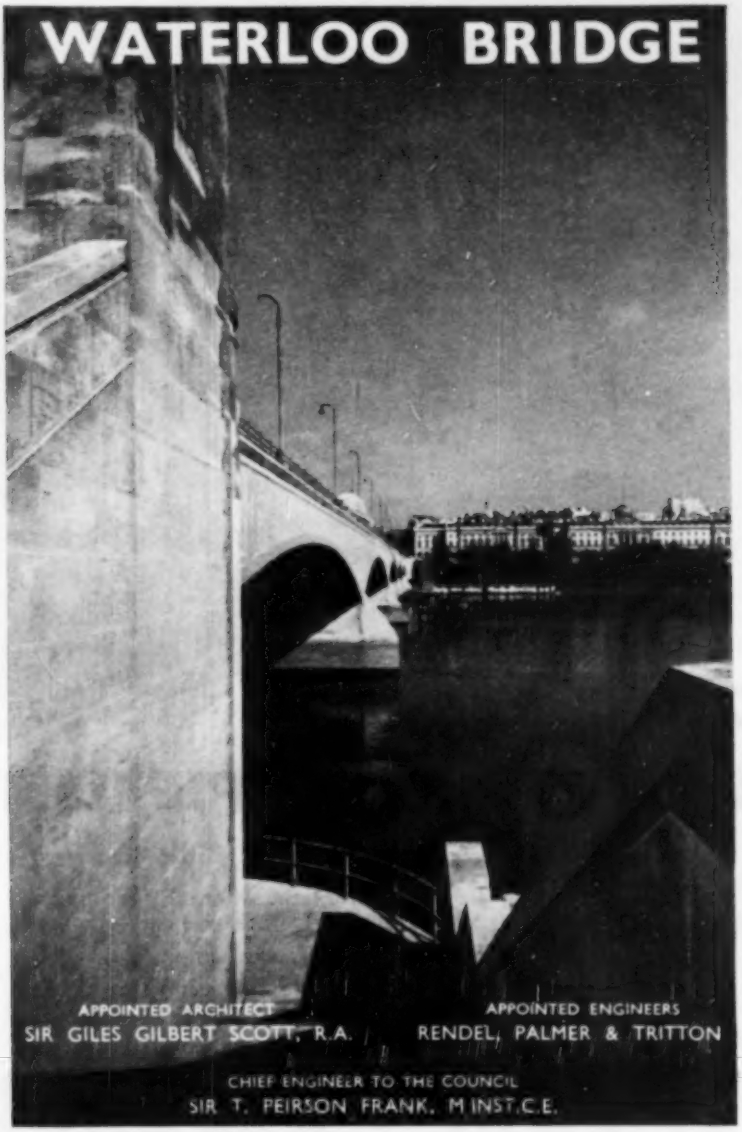
FLEXPAND EXPANSION JOINTING

Supplies can be obtained through Builders' Merchants.

D. ANDERSON & SON, LTD., STRETFORD, MANCHESTER

ROACH ROAD, OLD FORD, LONDON, E.3

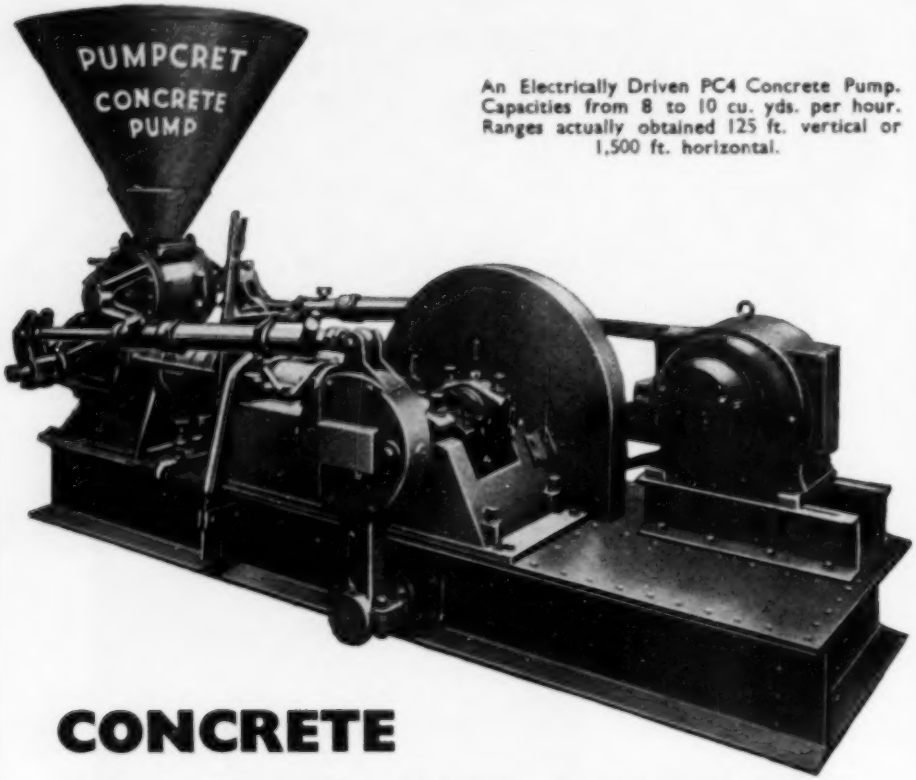
SCAFFOLDING
(GREAT BRITAIN) LTD.
PLANT DIVISION
Mitcham, Surrey
Telephone: MITCHAM 2400 (10 lines)
Telegrams: SCAFCO, MITCHAM
Branches at: ABERDEEN
BIRMINGHAM · BOURNEMOUTH
BRIGHTON · BRISTOL · CAMBRIDGE
CARDIFF · DOVER · DUBLIN
DUNDEE · EDINBURGH · EXETER · GLASGOW
HULL · LEEDS · LIVERPOOL · MANCHESTER
NEWCASTLE · NOTTINGHAM · OXFORD · PLYMOUTH
PORTSMOUTH · SOUTHAMPTON · STOKE-ON-TRENT
SWANSEA
SGB
I must always get my Steel Wheelbarrows from SGB—they save me a lot of money!
£sd



PETER LIND & CO., LTD

STRATTON HOUSE, PICCADILLY, LONDON, W.1

TELEPHONE: GROSVENOR 4601



An Electrically Driven PC4 Concrete Pump. Capacities from 8 to 10 cu. yds. per hour. Ranges actually obtained 125 ft. vertical or 1,500 ft. horizontal.

CONCRETE
BY PUMP AND PIPELINE

- The latest and most efficient method of placing concrete.
- Pump and Mixing plant can be located where it is most convenient for storing and handling aggregates and cement.
- The concrete is delivered by pipeline just wherever it is required with the minimum of interference with the building operations.
- The speed of the pump governs the whole of the concreting gang.
- Pumpable concrete must of necessity be good concrete.

THE CONCRETE PUMP COMPANY LTD

4 STAFFORD TERRACE, LONDON, W.8

Telephone: Western 3546. Telegrams: Pumpcret, Kens, London.

THORNTONS FOR REINFORCED CONCRETE CONSTRUCTION

The long list of contracts of all kinds and sizes carried out by us in reinforced concrete reflects the very wide experience we have had in this class of work. We undertake contracts in any part of the country, and invite Engineers and Architects to include our name on their lists for future enquiries.

William

THORNTON & SONS LTD

38 WELLINGTON ROAD
LIVERPOOL 8

REINFORCED CONCRETE ASSOCIATES

C

MOULD OILS & COMPOUNDS

for every process of concrete production

CONCREAM Regd.
VIBRAMOL Regd.
SPRAYMOL Regd.
"P.S." & "8.A"

CONCREAM

This non-staining, smooth and easy working white mould oil can be used with confidence on all classes of in situ and precast concrete work where the use of a white mould oil is recommended.

VIBRAMOL

This non-staining and non-separating mould oil is made specially for use on steel shuttering and moulds where vibrators are used, and provides a good film which is not readily moved under vibration.

SPRAYMOL

This grade of mould oil has been specially produced for use with a spray gun. It can be used with great economy on all types of shuttering and moulds, and will not separate under pressure.

"P.S."

Experience has shown that the production of precast and in situ prestressed concrete needs a special mould compound, and in collaboration with leading prestressed specialists we have produced Grade "P.S." Mould Compound for this class of work.

"8.A."

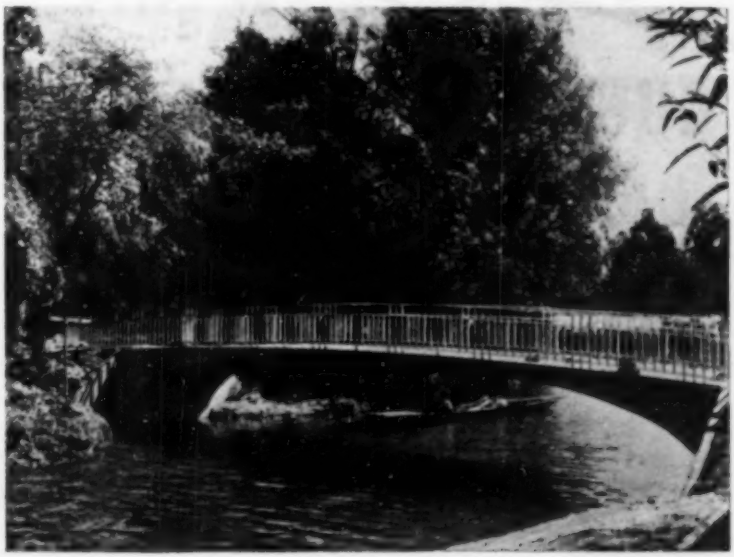
This Mould Compound has been specially produced to satisfy the requirements of those engaged in the production of spun concrete products.

PRODUCTS OF THE ORIGINAL MAKERS OF CONCRETE MOULD OILS

We specialise in the production of mould oils and compounds for concrete work of every kind, from mass concrete work to high-class architectural stone work, and have an unrivalled experience which enables us to give expert advice on all mould oil problems. We have a grade for every purpose, and will be pleased to submit full details, samples, and prices on request.

RICHD HUMBLE & SON, LTD., COLUMBA OIL WORKS, LEEDS, 3

Telephone : 27155. ESTABLISHED 1854 *Telegrams* : "Columba, Leeds, 3."



THE FIRST PRESTRESSED POST-TENSIONED FIXED ARCH BRIDGE CONSTRUCTION

The construction comprises two main prestressed post-tensioned arches. Spanned by prestressed pre-tensioned decking slabs. The arches are post-tensioned by the "Freyssinet" system. The span is 45 ft. clear and the design load is 100 lbs. per sup. ft. The depth of the arches at mid span is 9 inches.

CONSTRUCTED FOR THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF OXFORD

★

Design and Supervision by : R. Travers Morgan & Partners, Consulting Engineers

THIS SPECIALISED WORK WAS CARRIED OUT BY

TAYLOR WOODROW

AT HOME AND OVERSEAS

HEAD OFFICE AND WORKS : RUISLIP ROAD, SOUTHALL, MIDDX. PHONE : WAXLOW 2366. GRAMS : TAYWOOD, SOUTHALL. CODE : BENTLEY'S SECOND. LONDON OFFICE : 10 PARK STREET, W.1. PHONE : GROSVENOR 8871.

GUNITE AND CEMENTATION

★ Systematic repairs to structures based on systematic diagnosis of defects.

WHITLEY MORAN & CO. LTD.

Specialists in the Repair of Engineering Structures

5 OLD HALL STREET, LIVERPOOL. Telephone: Central 7975

---

10 Halden Branches

are ready to deal with your Photo Copying on the spot

Every Halden branch is fully equipped and ready to produce photo copies of plans, deeds, documents, etc., by any of the usual processes. To the larger user, Haldens offer a range of the most modern equipment for the production of their own photo copies. In connection with the production of maps, Haldens are licensed by the Controller of H.M. Stationery Office to reproduce Ordnance Survey Maps in one colour.

Haldens

OF MANCHESTER

J. HALDEN & CO. LTD.,
8, ALBERT SQ., MANCHESTER 2

Branches at :—London, Newcastle-on-Tyne, Birmingham, Glasgow, Leeds and Bristol.

THE WELLS HOUSE

C. H. James, R.A., F.R.I.B.A., Archt.

This attractive block of flats has recently been completed for the Borough of Hampstead.

The design of in-situ reinforced concrete and the supply of reinforcement thereto were carried out by Twisteel.

TWISTEEL
REINFORCEMENT LTD.

London: 43 Upper Grosvenor St., W.1. *Telephone: GROsvenor 1216* . Birmingham: Alma St., Smethwick, Staffs. *Telephone: Smethwick 1991* . Manchester: 7 Oxford Rd., Manchester, 1. *Telephone: Ardwick 1691*
Glasgow: Johnstons & Paton Ltd., 224 Ingram St., Glasgow, C.1. *Telephone: City 7661*

CONCRETE PROOFING CO. LTD.

GUNITE SPECIALISTS

Expert advice and schemes submitted for gunite work of every kind. Complete information on the various uses of gunite will be gladly sent on request.

100, Victoria Street, Westminster, S.W.1 Telephone: VICTORIA 7877 and 8278

B397

SPEED the fixing of all equipment with Rawlbolts and Rawlplugs. Get the machines and heavy stuff bolted down quickly, firmly, ready for immediate use with Rawlbolts—the dry fixing that does away with grouting-in and waiting for cement to dry. Fix the lighter fittings —switchgear, pipes, cables, lights—with Rawlplugs—the fastest and firmest screw fixings in the world!

RAWLPLUG

FIXING DEVICES

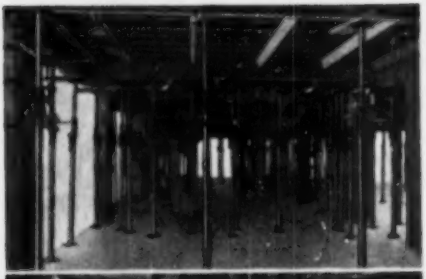
WRITE FOR TECHNICAL LITERATURE

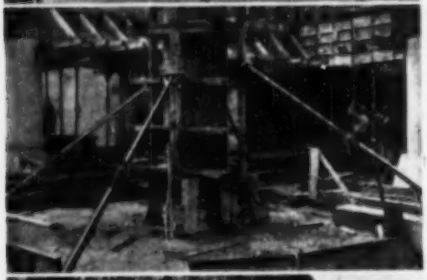
Use Rawlplug Fixing Devices where "speed is the essence of the contract"

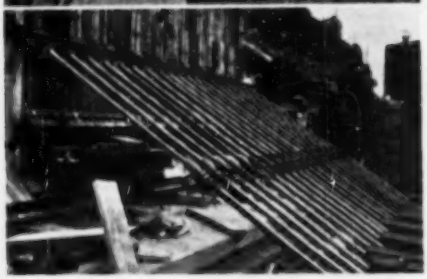
THE RAWLPLUG COMPANY LIMITED · CROMWELL ROAD · LONDON · S.W.7

INDUSTRIAL CONSTRUCTION
FACTORIES OFFICES
FOUNDATIONS
Government Factory and Administrative buildings at Chadwell Heath, Essex, by Kent & Sussex Contractors
KENT & SUSSEX
CONTRACTORS LTD.
LONDON · SIDCUP · BIRMINGHAM
Associated Company - RUSH & TOMPKINS (S.A.) LTD. Durban Natal.

Even where labou







CONSIDER SOME OF THE USES TO WHICH ACROW ADJUSTABLE STEEL PROPS CAN BE PUT TO SAVE TIME, LABOUR AND MATERIALS

Instead of 9×9's for shoring heavy formwork :
Raking columns :
Strutting wide trenches :
Underpinning temporary structures :
Raising roofs for increased head-room :
Lintel supports :
Jacking formwork :
Staircase shuttering :

Remember to send Acrow Props to every site

IT STANDS TO REASON IT

ACROW—the world's largest selling prop. Over 4,000,000 in use.

costs are lowest..

Photographed in South Africa

★ Only Acrow Props have the patent self-cleaning nut.

. . . they find it profitable to use

ACROW PROPS

WILL PAY YOU TO USE THEM

All enquiries to:—ACROW (ENGINEERS) LTD., 33 Catherine Place, **London,** S.W.1 (Victoria 0693)
130 Coventry Drive, **Glasgow,** E.1 (Bridgeton 1041) ● 22–24 City Road, **Bristol,** 2 (Bristol 24595)
West Stanley Street, **Manchester,** 5 (Trafford 2965) ● Lupton Street, Hunslet, **Leeds,** 10 (Leeds 76514)

GUNITE SPECIALISTS

WM. MULCASTER & CO. (CONTRACTORS) LTD.

We invite inquiries for Gunite Linings and Renderings for new or old structures of every kind in any part of the country.

HASLINGTON CREWE

Telephone: Crewe 2265-6.

BATSON

the best-known name in

CONCRETE MOULD OILS

"Releasol" ★ "Brownol"

Following a recent American test on reinforced concrete, it was confirmed that Batson's Mould Oil possessed a release efficiency that ranked first among the top ten lubricants tested. *A trial will convince you too.*

JOSEPH BATSON & CO. LTD. SOUTH STAFFORDSHIRE OIL & GREASE WORKS - TIPTON

Telephone: TIPton 1045. Established 1840.

CEMENTATION

WILL SEAL WATER LEAKAGES THROUGH CONCRETE, ROCK OR SUB-SOILS, AND WILL STABILIZE SUB-STRATA TO ARREST SETTLEMENT OF STRUCTURES ON FAULTY FOUNDATIONS. ALSO BY THIS PROCESS DETERIORATION OF CONCRETE OR OF MASONRY WORKS CAN BE REMEDIED.

BORED PILES

CAST *in situ* PILES CAN BE PUT DOWN TO GREAT DEPTH WITH A MINIMUM OF HEADROOM AND VERY LITTLE VIBRATION, WITH DESIGNED BEARING CAPACITY.
OUR WIDE EXPERIENCE IS AT YOUR DISPOSAL.

GUNITE

RECONDITIONING DAMAGED AND DEFECTIVE CONCRETE STRUCTURES.
ENCASING STRUCTURAL STEELWORK.
LINING TUNNELS, CULVERTS, RESERVOIRS.
COVERING THE WEARING SURFACES OF CHUTES AND BUNKERS.

THE CEMENTATION CO. LTD. BENTLEY WORKS, DONCASTER.

LONDON OFFICE: 39, VICTORIA STREET, S.W.1
TELEPHONE: ABBEY 5726-7-8.

— THE BETTER JOB

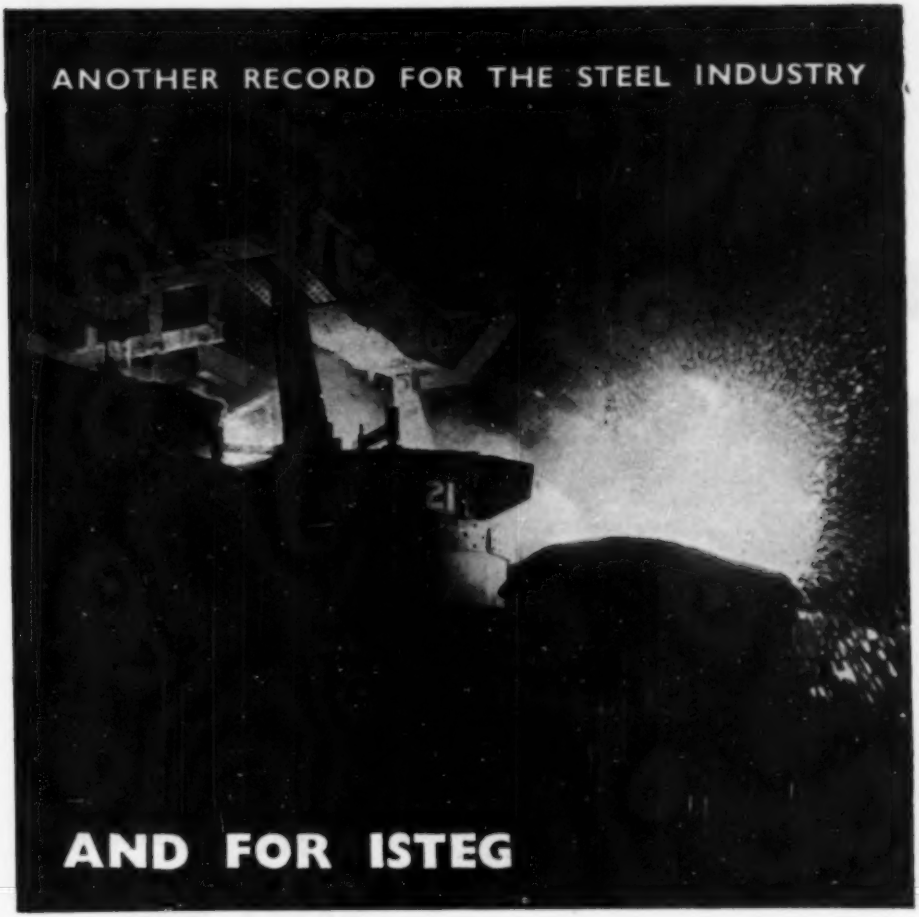
Builders and Contractors everywhere increasingly standardize on Wickham Hoists and Winches

a better, stronger and more reliable job

- The Wickham Builders' Hoists, all models, include
- A self-aligning quick fitting Tower Mast which takes SUBSTANTIALLY less time to erect.
- The Wickham Mast, because of its design and construction, has a SUBSTANTIALLY longer life.
- The Wickham Winch is fitted with heavy duty self-aligning ball-roller bearings which reduce SUBSTANTIALLY the annual cost of maintenance.
- The entire Winch and power unit is totally enclosed in a steel housing which reduces SUBSTANTIALLY the annual depreciation.
- Because of the protection afforded by the housing the Unit must have a SUBSTANTIALLY longer life.
- The Wickham Automatic Platform Control increases SUBSTANTIALLY the effective life of the Wire Bond.

And so — THE WICKHAM IS
— a better job.

Wickham ENGINEERING CO. LTD.
34 VICTORIA STREET LONDON SW1 ABBey 5967-8



Year by year the Steel Industry improves on its previous record output and year by year more Isteg is being used for Concrete Reinforcement. After all, what's the use of the Industry producing more steel if we don't make the best use of it.

Cold worked bars—such as Isteg—permit a working stress in tension 50% higher than plain steel bars. Wherever Isteg can be used to advantage, it saves one ton in three as regards steel and shows a worthwhile financial saving as well. For Concrete Reinforcement Isteg provides a higher safety factor; controls cracking and is backed up by an efficient delivery service.

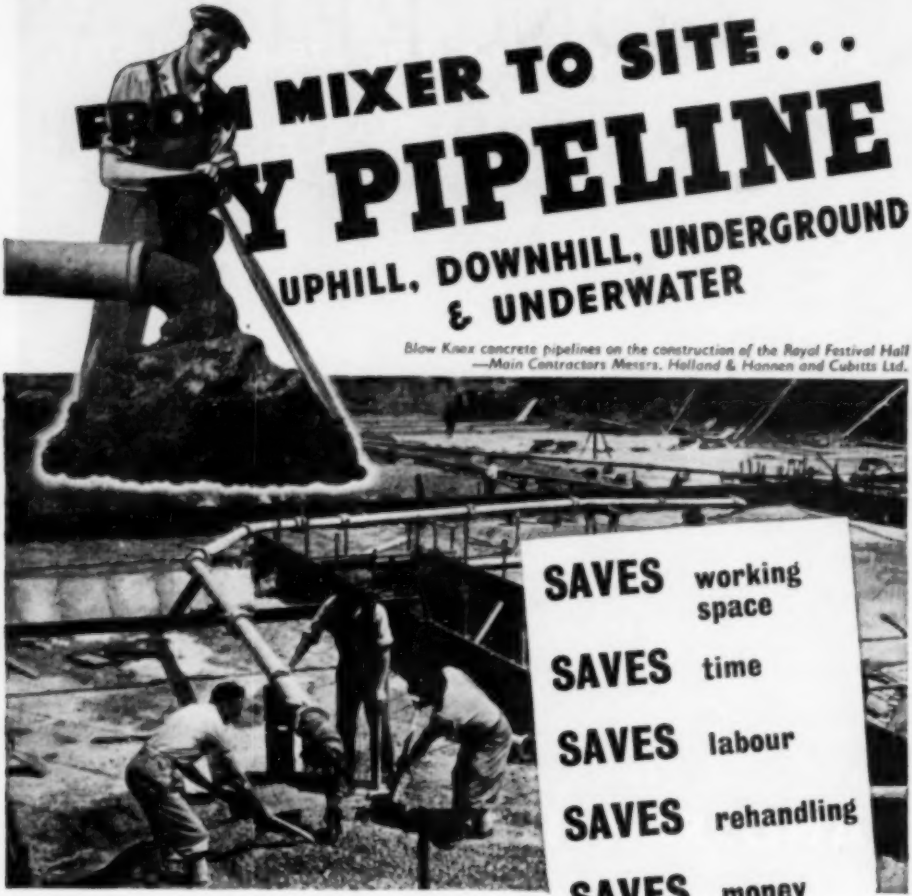
for Concrete Reinforcement ISTEG STEEL

ISTEG STEEL PRODUCTS LIMITED (SALES) 43 UPPER GROSVENOR ST., LONDON, W.1.

Tel.: GROsvenor 1216. ISTEG is manufactured by Guest Keen & Nettlefolds (Cwmbran) Ltd., Cwmbran
McCALL & Co. (Sheffield) Ltd., Templeborough, Sheffield
The United Steel Companies Ltd., Sheffield, and ISTEG STEEL PRODUCTS LTD.

FROM MIXER TO SITE . . .
BY PIPELINE
UPHILL, DOWNHILL, UNDERGROUND & UNDERWATER

Blaw Knox concrete pipelines on the construction of the Royal Festival Hall —Main Contractors Messrs. Holland & Hannen and Cubitts Ltd.



SAVES working space

SAVES time

SAVES labour

SAVES rehandling

SAVES money

Many contractors have found that the Blaw Knox Concrete Pump will eliminate wagons, chutes, hoists, towers, buckets, cranes and shovels AND REDUCE THE COST PER CUBIC YARD OF PLACED CONCRETE TO A NEW LOW LEVEL. Why not investigate the Blaw Knox Concrete Pumping System and see for yourself how significant an advance it really is. One man operation . . . speedier placing with no rehandling . . . easy to set up . . . extensible and adaptable . . . giving a steady flow of concrete uphill, downhill, traversing highways without obstruction to the traffic flow . . . tunnel lining undertaken without interruption to railway services . . . all these advantages and many more besides. Write for Catalogue 101.

BLAW-KNOX CONCRETE PUMP

BATCHING, MIXING AND BULK CEMENT PLANT · CONCRETE MIXERS · MOTOMIXERS · CONCRETE PUMPS · CONCRETE SPREADERS AND FINISHERS · CONCRETE BUCKETS · STEEL SHUTTERING · ROADFORMS · DEWATERING PLANT EXCAVATORS · LAND CLEARING EQUIPMENT · EARTH MOVING EQUIPMENT

BLAW KNOX LTD · 11 CLIFTON HOUSE · EUSTON RD · LONDON · EUSTON 5361

CONCRETE AND CONSTRUCTIONAL ENGINEERING

Volume XLV. No. 10. LONDON, OCTOBER, 1950

EDITORIAL NOTES

Engineering and the Arts.

IN order "so to strengthen and extend the engineer's mental equipment that, in later years, he may be an acceptable candidate for the highest administrative posts" a course in arts subjects is now available for engineering students at University College, London, during the "suspense" year between the final examinations and the award of degrees. Although we must say that we think that the word mind or knowledge would be better than mental equipment, we welcome this innovation as a step in the direction that we have been advocating for many years. The experience and the views of two students of electrical engineering who have had the advantage of this brief introduction to the arts are given in the Journal of the Engineers' Guild. The course comprised eighteen hours of lectures a week, more than half of which dealt with pure mathematics, law, economics, and the presentation of technical information. In the course of their report these students say: "We began the year with some resentment at the regulation which dictated so much apparently wasted time. This feeling has given way to alarm at the thought that so many engineers have graduated without it. These things that we have been studying are the very stuff of the civilisation we live in. As he grows older, the engineer doubtless acquires a working knowledge of his country's laws and economy, and learns to express himself with some clarity. But with what pains he often gains this knowledge; at the expense of how many misapprehensions and uncertainties! The greatest benefit of the course was that our minds received a tremendous stimulus. To know more and more theory about engineering was undoubtedly useful, but we felt, and were often told, that the engineer must know the world about him and his place in that world. . . . It is good to know that these extra subjects are to be introduced to all engineering students at the College under the new regulations which increase the degree course by one year. . . . We think that we have been fortunate to take this fascinating course. We hope, too, that other organisations will see fit to give their students such a course, and so turn out engineers, not better qualified technically, but better educated to take part in industry and life." The desirability of still further time being given to the study of the arts can be seen in the report of these two students; for example, a more careful study of words would have prevented them from writing that the College had "run a course" and "turned out" engineers. They say that some of the students wrote books and attempted to get them published in their first enthusi-

asms after attending a few of these lectures; further study would have dissuaded them from writing books so precipitately, for one of the most important things that a study of arts teaches is the extent of our ignorance.

A study of the meaning of words is much needed in the engineering profession. Take, for example, the following definition from a recent British Standard Code prepared by a committee of engineers: "Folding wedges. Wedges used in pairs, folding over each other and driven in opposite directions in order to hold or force apart two parallel surfaces." First, it is not possible to fold wedges over each other, although it is a simple matter to fold (or place) one above another. Secondly, by the use of the word "over", the definition takes no account of folding wedges used between vertical surfaces, where they lie side by side. Thirdly, it is sometimes better to drive one of the wedges in one direction only. And, fourthly, there is no reason to restrict the number of wedges to two if, as is sometimes the case, three would be better. In the same code a manhole cover is defined as a casting, although it is hardly likely that it is intended that pressed steel covers shall never be used. Such misuse and carelessness in the use of words are no doubt among the reasons that cause non-technical people to doubt the wisdom of engineers and scientists, for how, it may reasonably be asked, can wisdom be present in persons who cannot say and write what they mean?

In discussing education in a recent book which has had a large sale, the authors say: "This expansion [of the universities] is primarily aimed at the production of the vast number of scientists prescribed by the Barlow report as a panacea for our economic and technological anæmia. So long as the universities persist in turning out scientists so narrowly specialised, so ignorant of everything outside a narrow sector of science itself as to be totally unaware even that they lack culture, a vast expansion of science faculties may well prove a mixed social blessing. The universities have themselves perceived the danger, and have sought to counteract it by the palliative expedient of expanding arts faculties as nearly as possible in proportion. . . . To suggest that it is no part of the function of universities to provide vocational training would be ridiculous. But it is pertinent to ask whether they ought to turn out half-baked 'scientists' who are largely ignorant of literature and who have the haziest idea of the historical processes which gave rise to scientific discoveries and of the social and ethical framework in which science operates to-day. . . . The mediæval universities did not turn out such half-men." These criticisms are spoilt by exaggeration and generalisation, but nevertheless they express views which are commonly, though less vehemently, held. It is to be hoped that the study of arts subjects by engineering students at University College will be extended, and that similar courses will be introduced at other universities and technical colleges. It is a pity that men trained in technical subjects should so often have to wait until middle age or later before they have an opportunity of being whole men, or even learn how to express themselves in their own language.

Design and Construction of a Prestressed Concrete Arch Footbridge at Oxford.

By A. GOLDSTEIN, B.Sc.(Eng.), A.C.G.I., D.I.C.

A PRESTRESSED concrete footbridge (*Fig.* 1) replacing a timber structure over the river Cherwell in the Oxford University parks has recently been constructed. A concrete arch of one span was selected from a number of preliminary designs. The shape of the arch was determined as a result of the desirability of a small rise of the deck, sufficient clearance for river craft, and consideration of æsthetics. *Figs.* 2 and 3 give the dimensions and details of the bridge, which comprises two fixed prestressed concrete arches braced laterally at the ends and centre by cast-in-situ reinforced concrete beams. The deck is formed of prestressed precast concrete planks bedded on cement mortar and laid with spaces between them to

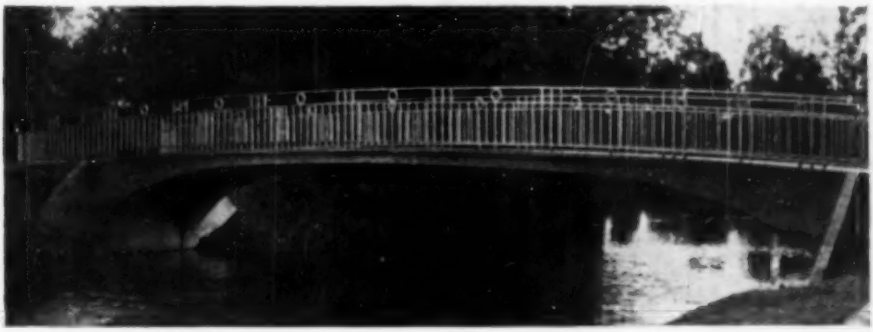


Fig. 1.—Footbridge at Oxford.

facilitate drainage. A feature of the shape of the bridge is the shallow depth at the middle part and the downward curve of the intrados at the ends. It is believed that this is the first prestressed statically-indeterminate arch constructed in this country, and the writer has not been able to trace the existence of a prestressed "fixed" arch elsewhere.

Design.

The primary design excluding the effect of prestressing was based on the usual formulæ for a fixed arch as given later. First a shape of generous dimensions was assumed, and adjusted to give the final shape. The extrados of the central part of the arch is a circular arc with a rise of 1 ft. The shape of the intrados was determined by eye. A final primary design was then made using the adjusted shape of the arch.

Determination of the effects of prestressing is less straightforward. When a statically-indeterminate structure is prestressed, the line of pressure of the prestressing forces is not coincident with the centre-line of the cables because of strains in the structure, and in the structure being described there are three indeterminacies. It is, therefore, not possible to determine the prestressing effects

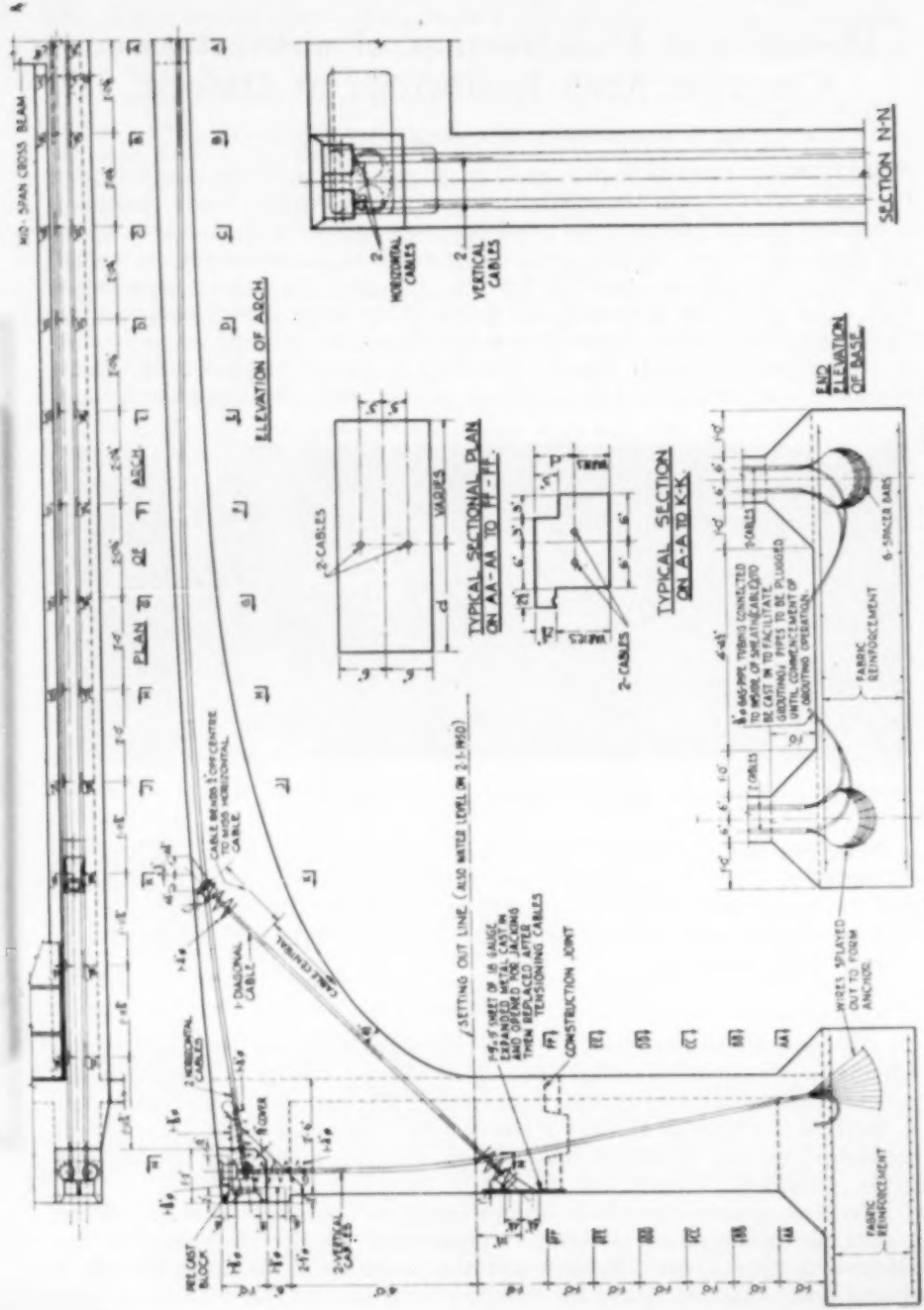


Fig. 2.—Prestressed Concrete Footbridge, Oxford.

at any section of the arch in a similar manner to that normally adopted for statically-determinate structures. The difficulty could be overcome by providing temporary pin-joints at certain points to make the arch statically determinate during prestressing. The joints could then be grouted solid and the structure would act as a fixed arch under the live load only. This method saves time in the design, but, in the writer's opinion, the result is uneconomical and construction is complicated. The formulæ for the method adopted in the design of this bridge are summarised later.

The alignment of the cables (*Fig.* 2) was first determined from the primary design. The secondary design, to calculate the effects of prestressing, was then made in general terms. By equating the primary and secondary stresses at a number of critical sections of the arch to the permissible stresses, it was determined that two horizontal cables of eight wires each, two vertical cables of ten

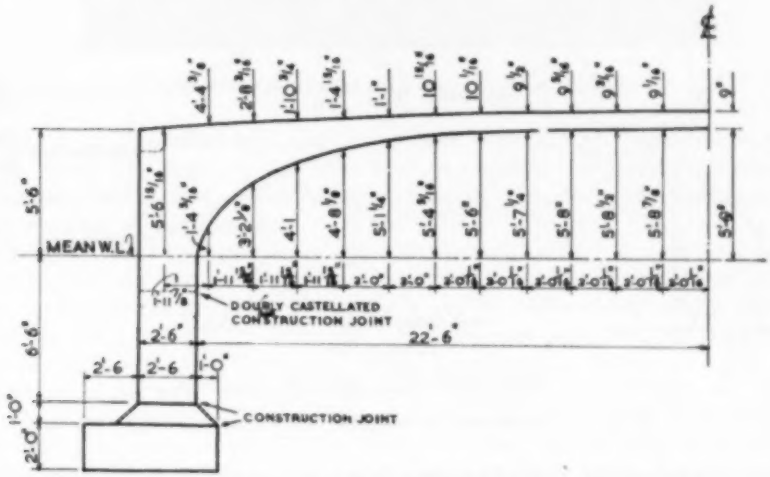


Fig. 3.—Dimensions of Arch. (Width of Arch Rib : 12 in.)

wires each, and one diagonal cable of twelve wires were suitable. The wires are 0·2 in. diameter and were stressed to 150,000 lb. per square inch by the Freyssinet system. *Fig.* 4 shows the calculated stresses for the dead load (that is the weight of the arch only), and for the total load. The peaks of tensile and compressive stresses obtained at the anchorages are purely theoretical since the loads at the anchorages are assumed to act as point loads. As these loads are distributed to some extent, it was not considered that the high stresses represented by the peaks would occur, and this view is verified by measurements of the strains of the arch.

The reliability of the assumption of complete fixity at the base of the arch was considered, and the effect of rotation was determined in the primary and secondary designs. The result was sufficiently reassuring for the working design to be that of a fixed arch, particularly as contra-rotation occurs during prestressing if fixity is not complete.

The bases of the arches comprise single slabs reinforced with wire fabric. The

ground pressures, particularly those due to eccentric forces, are small. The vertical prestressing cables are continuous and extend into the bases where the wires are splayed out to form an anchorage of the shape shown in *Fig.* 5. Where the horizontal and vertical cables terminate at the outside corner of the structure, anchorage is provided by precast concrete blocks (*Fig.* 6), in which are embedded cones of the Freyssinet type placed in the shuttering before concreting.

Construction.

A trial hole showed that good firm blue clay occurred 18 in. below mean water-level, but during excavation sandy clay was encountered about 2 ft. above the intended level of the foundation. The sandy clay was not impervious and, due

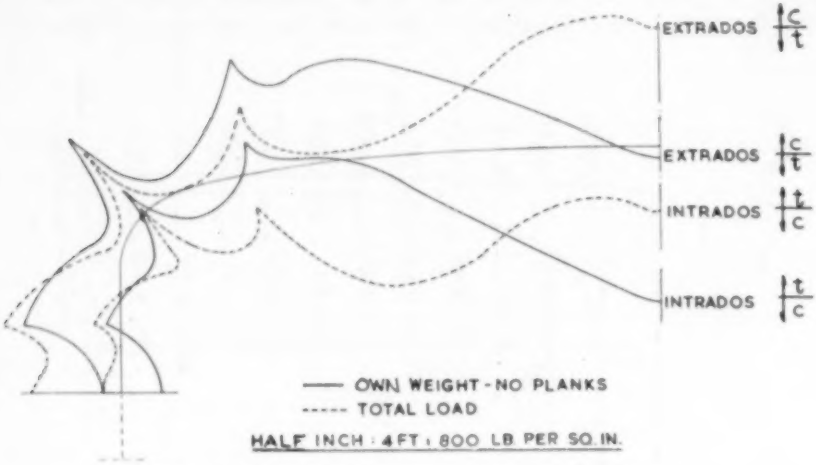


Fig. 4.—Calculated Stresses: All Cables acting.

to the possibility of the ground heaving if further excavation were attempted, the foundation slabs are an average of 2 ft. 6 in. higher than was originally intended. The bottom of the excavation was sealed immediately by paving slabs and rapid-setting concrete to avoid the trouble which might otherwise have occurred since, notwithstanding the effectiveness of the cofferdam, seepage was occurring from below. In order further to consolidate the ground, 2 ft. of mass concrete was placed on top of the foundation slabs but clear of the legs of the arch. The design of the bridge was then investigated to determine the effect of the shortening of the legs; the effect is not great and did not necessitate any alteration other than changing the position of the vertical cables.

The cables were made on the site and are sheathed in thin metal tubes. The tubes are in lengths of 2 ft., the joints being covered with tape to avoid leakage of cement grout. Gas pipes are embedded in the aperture of the end anchorage and extend clear of the concrete to ensure complete grouting and to avoid airlocks. Each wire was numbered to ensure it being in the correct sequence at both ends.

The shuttering (*Figs.* 7 and 10) was of timber lined with hardboard on all visible faces and was made in sections at the contractor's works and assembled

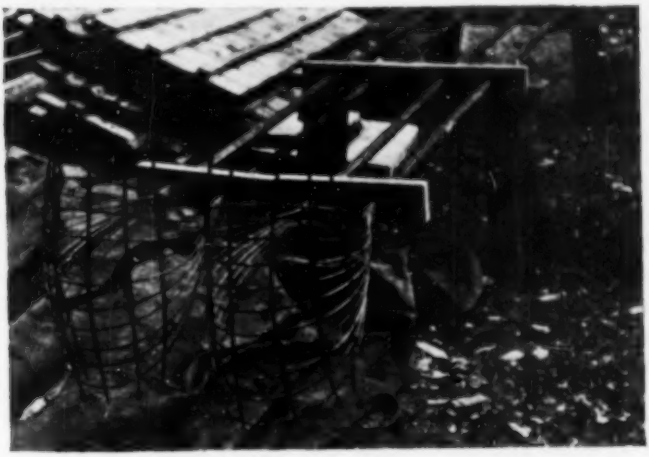


Fig. 5.—Anchorage-loops on Vertical Cables.

on the site. The cables were kept in position vertically by ½-in. rods connected to the inner side shutters, and were kept in position horizontally by templates which were withdrawn as concreting proceeded. The rods were extracted after the initial set of the concrete.

Fig. 2 shows the position of the construction joints. A doubly-castellated construction joint was used between the vertical and horizontal parts of the arch. The mixture of the prestressed concrete is 112 lb. of Portland cement, 177 lb. of sand, and 315 lb. of ¾-in. aggregate, the materials being batch-weighed. The water-cement ratio was about 0·48 in the foundations and legs and 0·50 in the main part of the arch (*Table* I). For the visible part of the bridge, the concrete for which was placed in one cast, cement was obtained in the London district as the local cement produced a rather dark concrete. An immersion vibrator was used. Test cubes, which were not vibrated, were made from each cast, and the

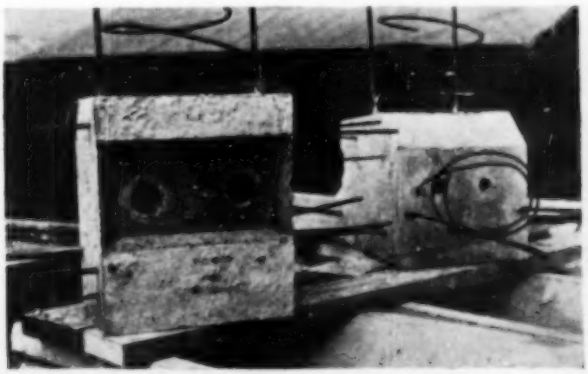


Fig. 6.—Anchor-blocks for Vertical and Horizontal Cables.

TABLE I.—PROPERTIES OF CONCRETE.

Position	Water-cement ratio (by weight)	Weight (lb. per cu. ft.)	Crushing strengths (lb. per square inch)			
			3 days	7 days	14 days	28 days
Foundation Slabs .	0·48	157	3110	5822	7095	7891
Vertical Legs . .	0·48	155	—	—	7258	7558
Arch (main casting)	0·50	154	4870	6158	—	6910
Precast Blocks .	0·50	149	3227	4439	—	5816

average strengths and weights of the cubes are given in *Table* I. The specified strength was 6000 lb. per square inch at 28 days. It is seen in *Table* I that the cubes are particularly heavy, and this no doubt is one reason for the high strengths. The concrete in the anchorage blocks is made with $\frac{1}{2}$-in. aggregate and cubes of this concrete had lower strengths, as was expected. The side shutters were struck after 24 hours and the concrete had a good surface before rubbing down. Arrises were sharp, and the finish and colour of the concrete were as intended.

Prestressing would have been possible about four days after casting, but storms caused the water in the river to rise to such an extent that prestressing had to be postponed, and eventually this operation took place after eleven days. The vertical cables of both arches were stressed in pairs first, followed by the diagonal cables, and finally the horizontal cables. After some false starts, due to trouble with the plant, the work was done without difficulty in about nine hours. Two jacks were used. The central connecting beam and wing walls were cast after prestressing the arches. During the period of construction, the river was closed for about one week.

Measurements of Deflection and Strain.

The deflection at the centre of the arch was measured at the end of the prestressing operations. The calculated deflection was slightly under $\frac{7}{32}$ in. and

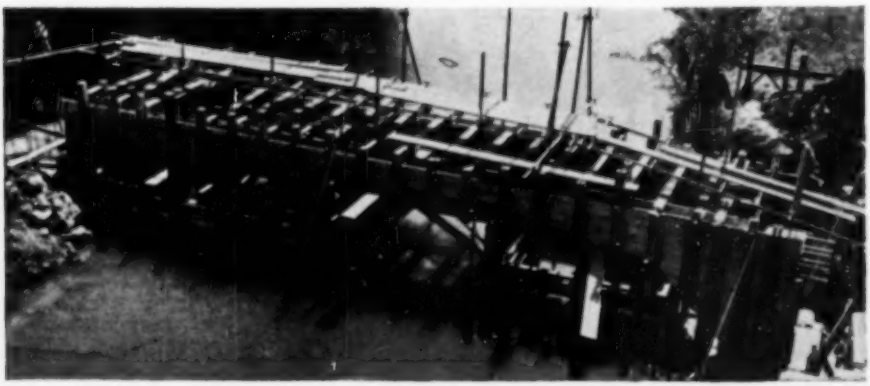


Fig. 7.—Centering and Shuttering.

the measured deflections (upwards) were $\frac{7}{32}$ in. in the northern arch and $\frac{1}{4}$ in. in the southern arch.

A strain-gauge measuring 0·0001-in. extension on 8-in. gauge length was used to determine the strains of the concrete at several points on both arches. Readings at most of the points were taken at one-half and full prestress of each cable. A specimen of the concrete was tested to determine the elastic modulus at different stresses, and stresses were computed from the strains using the appropriate value of the elastic modulus. The calculated stresses when one cable only is acting are plotted in *Fig.* 8, and for all cables and dead load acting in *Fig.* 9. Considering all factors, the comparison between the calculated stresses and those obtained from the measured strains is reasonably good.

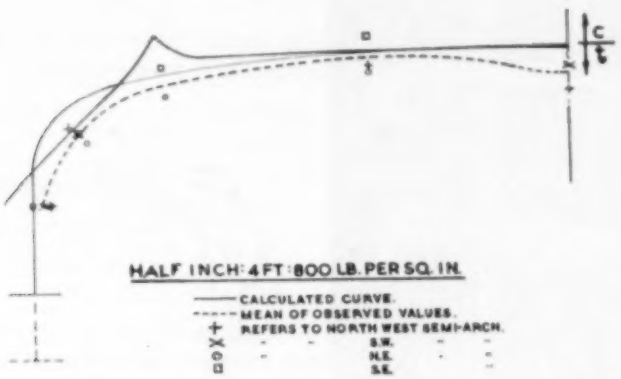


Fig. 8.—Stresses at Extrados: Diagonal Cables only acting.

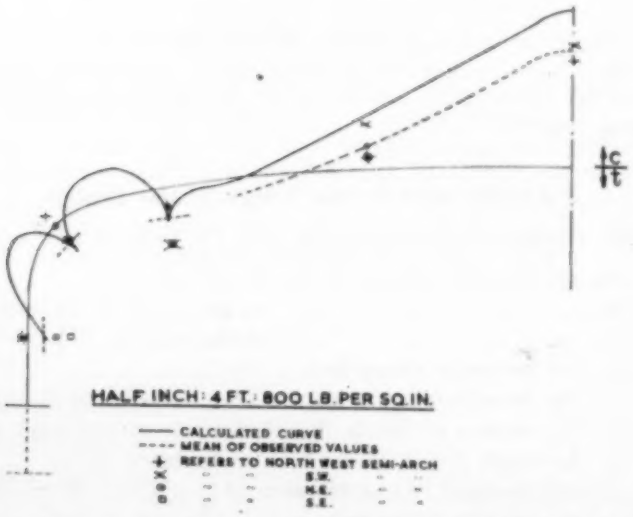


Fig. 9.—Stresses at Intrados: All Cables and Weight of Arch acting.

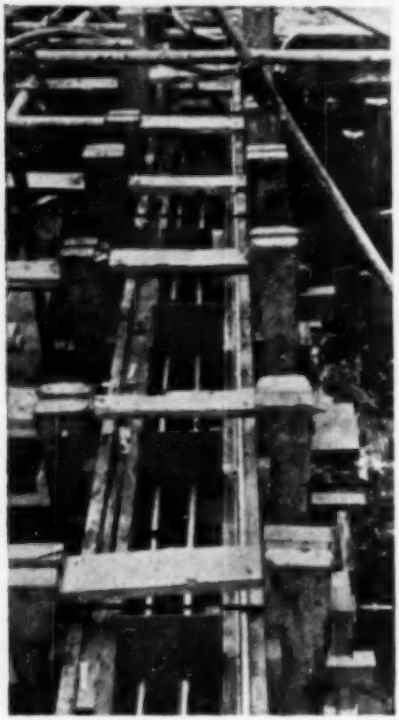


Fig. 10.—Shuttering for Beam.

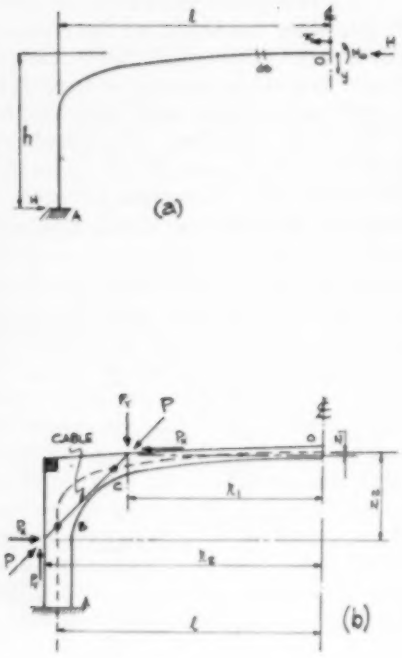


Fig. 11.

After completion of the structure a small loaded motor-van, having a total weight of about 2 tons, was driven on to the middle of the bridge and produced a deflection at the centre of the arch of $\frac{1}{16}$ in. Complete recovery occurred when the load was removed.

Formulæ used in the Design of the Bridge.

PRIMARY DESIGN.—Referring to *Fig.* 11*a*, the symbols used are

M_S, the bending moment (ft.-lb.) at any point S.
M_O, " " " " at the centre of the arch.
M_A, " " " " at the base A.
H, the horizontal thrust (lb.).
w, the intensity (lb. per foot) of the uniformly-distributed load.
I_S, the moment of inertia (ft.) of the arch at any point S,
d_S, the depth (ft.) of the arch at any point S,
l, half the span (ft.) of the arch.
h, the rise (ft.) of the arch.
U, total strain energy.

From the equations of strain energy, $\frac{\partial U}{\partial H} = \frac{\partial U}{\partial M_O} = 0$.

$$M_S = M_O + H_Y - \frac{wx^2}{2} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Since $\frac{\partial M_S}{\partial H} = y$ and $\frac{\partial M_S}{\partial M_O} = 1$,

$$\int_O^A \frac{M_O}{I_S} ds + \int_O^A \frac{Hy}{I_S} ds - \int_O^A \frac{wx^2}{2I_S} ds = 0 \quad . \quad . \quad . \quad (2)$$

and

$$\int_O^A \frac{M_O y}{I_S} ds + \int_O^A \frac{Hy^2}{I_S} ds - \int_O^A \frac{wx^2 y}{2I_S} ds = 0 \quad . \quad . \quad (3)$$

Equations (2) and (3) are solved simultaneously to determine the values of H and M_O. The integrals are calculated graphically from values tabulated thus:

Point (S)	x	y	i_S	I_S	$\frac{1}{I_S}$	$\frac{x}{I_S}$	$\frac{y^2}{I_S}$	$\frac{x^2}{I_S}$	$\frac{x^2y}{I_S}$
0	0	0	0·75	0·035	28·6	0	0	0	0
1	1·0	0	0·75	0·035	28·6	28·6	0	28·6	0
2	2·0	0·021	0·76	0·036	27·8	55·6	0·012	111·2	2·34
etc.									

The integrals can be determined by plotting the tabulated functions and measuring the areas of the diagrams so obtained by a planimeter. If the distances ds are equal (in this example, 1 ft.), Simpson's rule can be applied. Substituting H and M_O in equation (1) gives M_S, and

$$M_A = M_O + Hh - \frac{wl^2}{2}.$$

The stresses at each section are calculated by combining the bending moment at, and the thrust normal to, the section in the usual manner.

SECONDARY DESIGN (*Fig.* 11*b*).—If a straight cable, such as the diagonal cable in the bridge, tensioned by a force P acts on the arch, it can be replaced by two equal and opposite forces P which act at the extrados, as in *Fig.* 11*b*, and which can be resolved vertically and horizontally as P_Y and P_X. The strain-energy equations are applied as in the primary design. Also

From O to C:

$$M_S = M_O + Hy \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

From B to C:

$$M_S = M_O + Hy + P_X(y - z_1) - P_Y(x - r_1) \quad . \quad . \quad . \quad . \quad . \quad (5)$$

From A to B:

$$M_S = M_O + Hy + P_X(y - z_1) - P_Y(x - r_1) - P_X(y - z_2) - P_Y(r_2 - l)$$
$$= M_O + Hy + P_X(z_2 - z_1) + P_Y(r_1 + l - r_2) \quad . \quad . \quad . \quad . \quad (6)$$

In equations (4) to (6), $\frac{\partial M_S}{\partial H} = y$, $\frac{\partial M_S}{\partial M_O} = 1$, and

$$\frac{\partial U}{\partial M_O} = \int_O^C \frac{M_O + Hy}{I_S} ds + \int_C^B \frac{M_O + Hy + P_X(y - z_1) + P_Y(x - r_1)}{I_S} ds + \int_B^A \frac{M_O + Hy + P_X(z_2 - z_1) + P_Y(r_1 + l - r_2)}{I_S} ds = 0,$$

which reduces to

$$\frac{\partial U}{\partial M_O} = \int_O^A \frac{M_O}{I_S} ds + \int_O^A \frac{Hy}{I_S} ds + \int_C^B \frac{P_X y}{I_S} ds + \int_B^A \frac{P_X z_2}{I_S} ds - \int_C^A \frac{P_X z_1}{I_S} ds + \int_C^A \frac{P_Y r_1}{I_S} ds - \int_C^B \frac{P_Y x}{I_S} ds + \int_B^A \frac{P_Y (l - r_2)}{I_S} ds = 0 \qquad (7)$$

Similarly, $\frac{\partial U}{\partial H} = \int_O^A \frac{M_O y}{I_S} ds + \int_O^A \frac{Hy^2}{I_S} ds + \int_C^B \frac{P_X y^2}{I_S} ds + \int_B^A \frac{P_X y z_2}{I_S} ds - \int_C^A \frac{P_X y z_1}{I_S} ds + \int_C^A \frac{P_Y y r_1}{I_S} ds - \int_C^B \frac{P_Y y x}{I_S} ds + \int_B^A \frac{P_Y y (l - r_2)}{I_S} ds = 0 . \qquad (8)$

By solving equations (7) and (8) simultaneously, M_O and H are determined, and substitution in equations (4) to (6) gives M_S. The values of the integrals in (7) and (8) can be computed graphically as in the primary design. Stresses at any section can then be obtained in the usual manner by combining the bending moments and thrusts.

If the cables are curved, additional loads must be applied to allow for the curvature of the cable. The method is then only approximate and care must be exercised in selecting the equivalent loads.

Conclusions.

The lessons learned in the design and construction of even such a small structure as this are valuable. From the experience gained, neater design methods can be adopted for bridges of the same size or larger. The value of the deductions from the site measurements cannot be over-emphasised, and the analysis of these measurements defines the limits of the assumptions and approximations made in the design. In the writer's opinion, a small amount of rotation of the bases occurred during prestressing but, as this was a contra-rotation, the assumption of fixity was justified.

Prestressed statically-indeterminate structures are frequently very economical, and the complexity of the analysis of the prestressing effects on such structures need not be a deterrent to their use. It should be noted that the shape of the cables in this structure is approximately that of "concordant cables" advocated by some French engineers,[1] a method of design which is very suitable for this type of structure and which facilitates work in the drawing office.

The author acknowledges his thanks for permission to use the data given in this article to the consulting engineers, Messrs. R. Travers Morgan & Partners, and for the photographs to Mr. L. W. Williams of Taylor Woodrow Construction, Ltd., the main contractors.

[1] M. Y. Guyon.—Institute Technique du Batiment et des Travaux Publics. Circular No. 8 (Series J). September, 1948.

Rapid Concrete Construction in Spain.

By N. B. BOURNE, M.A., A.M.Inst.C.E.

A HOSPITAL (*Figs.* 1 and 2) being built for the Spanish National Health Services at Cruces in Baracaldo, Bilbao, is a striking example of rapid construction in reinforced concrete. A feature is a helical staircase.

The plan is a circular arc with radial wings which follow the contours of the site and avoid excessive excavation. The building is founded on rock by excavat-

Fig. 1.—Hospital during Construction.

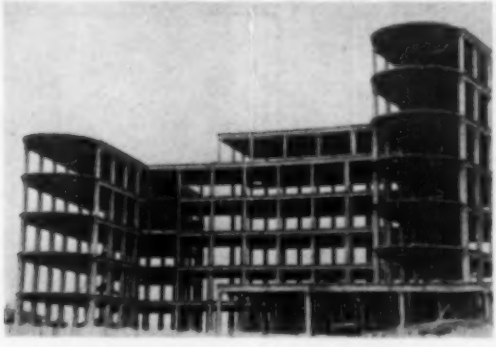


Fig. 2.—Cantilevered Balconies.

ing wells and filling them with mass concrete to depths varying up to 26 ft. The structure, which is divided into eight parts by permanent joints, comprises cast-in-situ reinforced concrete columns, slabs, and beams. The floors and roof (which is to be used as a terrace) are designed for a live load of 40 lb. per square foot. The wind pressure was assumed to be 20 lb. per square foot on the upper two-thirds only of the building. The main beams are of standard cross-sections, generally about 23½ in. deep and 8 in. wide, but sometimes increasing to 20 in. wide. Some intermediate beams are 16 in. square. The beams are standardised by having the same reinforcement throughout the top and bottom, but with

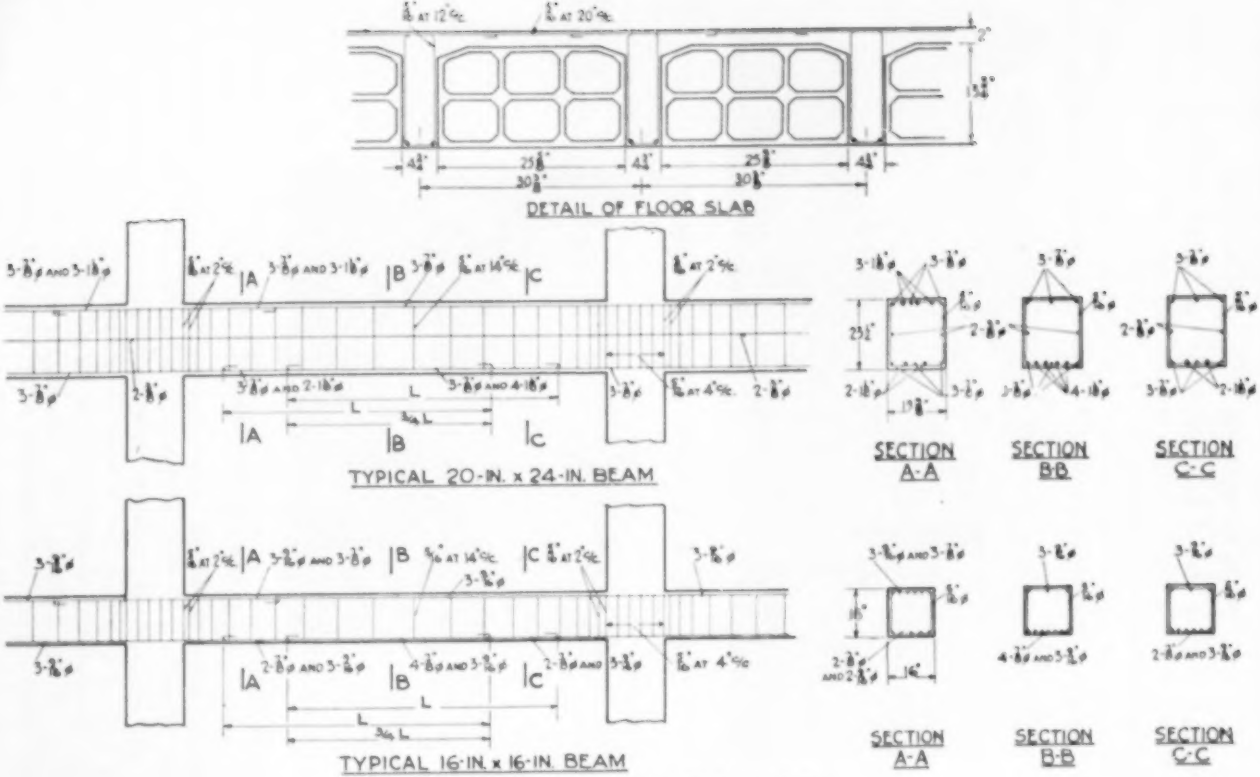


Fig. 3.—Details of Floor Slabs and Beams.

additional bars at midspan and over the supports calculated for each beam (*Fig.* 3). There are no bent-up bars. This system of reinforcement and the notation used on the drawings simplified the work. The secondary beams are at 30 in. centres and have a depth of 16 in. throughout and span generally 23 ft. to 26 ft., although in some cases the span is 32 ft. 9 in. The spaces between the secondary beams are filled with hollow concrete blocks (*Fig.* 3). The rigidity

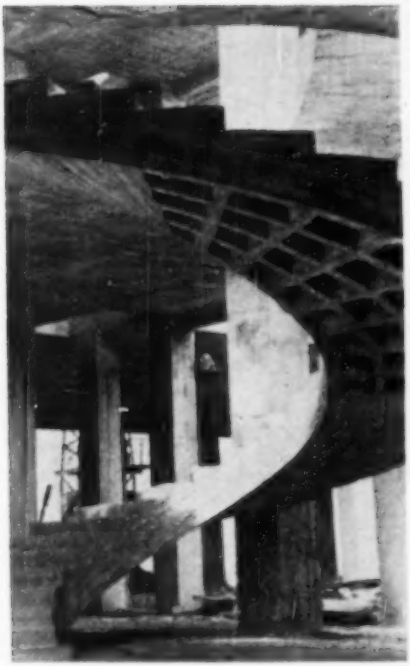


Fig. 4.—Helical Staircase at Ground to Floor.

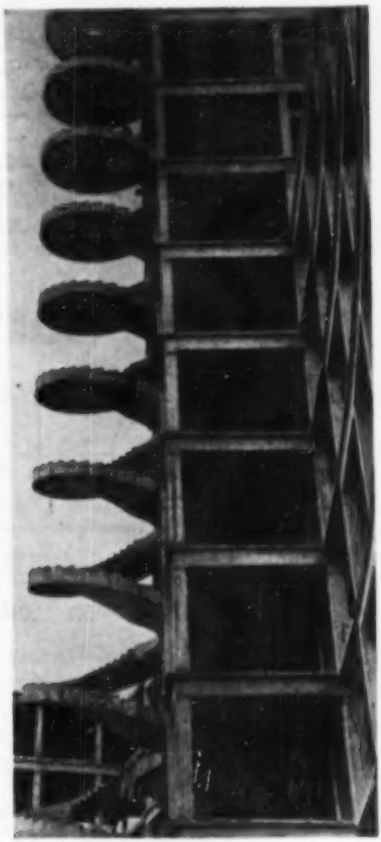


Fig. 5.—Helical Staircase.

of the structure enables it to resist horizontal forces due to wind and eccentric loads without transverse beams.

The main staircase (*Figs.* 4 and 5) is a helix, having an outside diameter of 19 ft. 7 in. Two-thirds of the stair structure is cantilevered and is built into each floor. It is composed of a 15-in. slab the weight of which is reduced by cells on the underside. Details of the staircase are given in *Fig.* 6, which shows the anchorage to each floor. A cage above the helical staircase is designed to

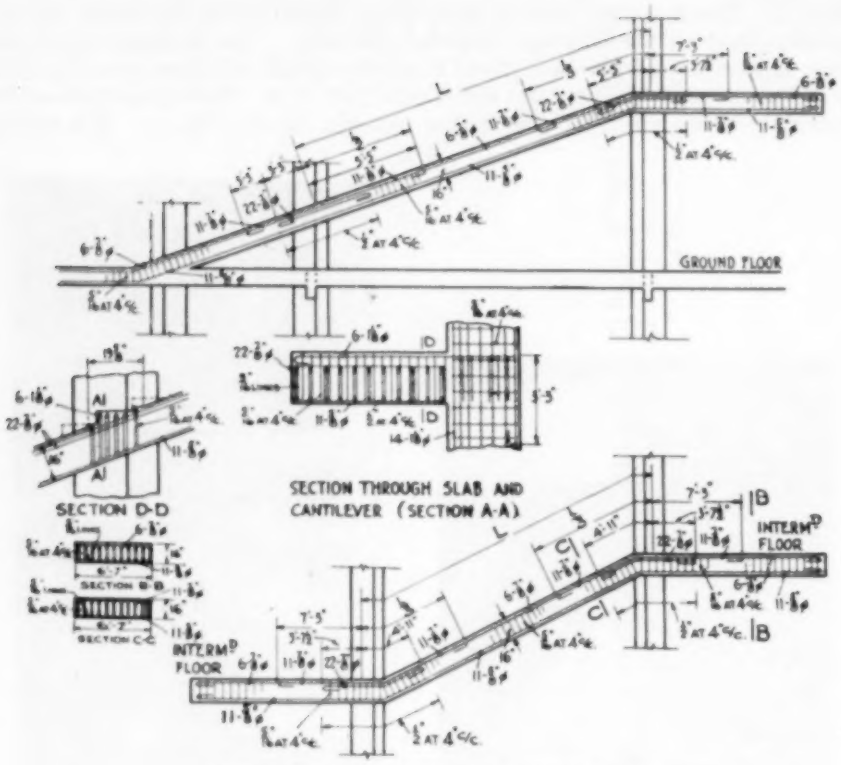


Fig. 6.—Details of Helical Staircase.

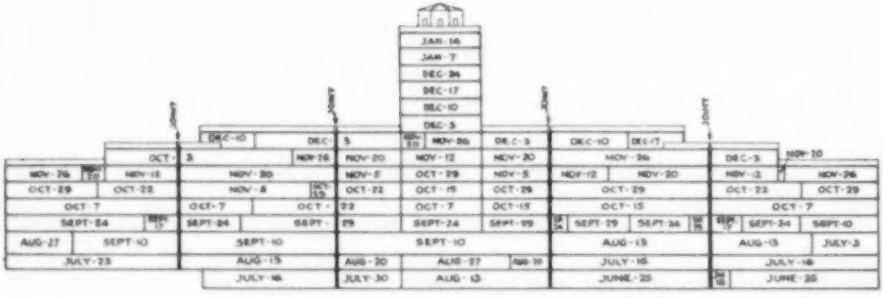


Fig. 7.—Dates of Concreting Successive Parts.

support a monument which will weigh about 40 tons and be subjected to large wind pressures and which will be mounted on a circular bow girder 3 ft. 9 in. deep and 12 in. wide, anchored at the rear to two of the main columns and supported at the front on two other columns.

The semi-circular bays seen in *Fig.* 2 which, like the staircase, are to be entirely covered with glass and which are the sitting-rooms corresponding to each group of wards, have a radius of 14 ft. 7 in. and comprise cantilevered slabs 16 in. thick at the support reducing to 6 in. thick at the outer edge.

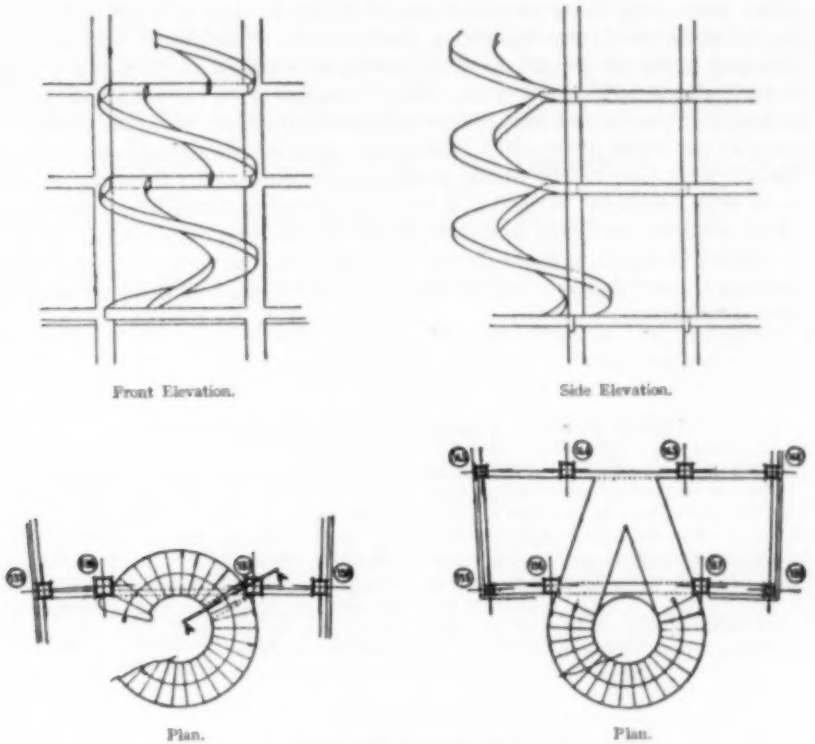


Fig. 8.—General Arrangement of Helical Staircase.

In spite of the large spans of the beams and slabs and overhangs of the cantilevers, the average amount of reinforcement in the building is 5·1 lb. per square foot of floor; this quantity includes the reinforcement in the columns. The total floor area is 377,000 sq. ft.

The principal quantities are: Excavation, 23,500 cu. yd.; Filling, 30,000 cu. yd.; Mass concrete in foundations, 7,800 cu. yd.; Reinforced concrete, 13,000 cu. yd.; Reinforcement, 900 tons. Work started in June, 1949, and roof level was reached in January, 1950. The structural work was completed in 118 working days of eight hours, and the maximum number of men employed was 350. This was a remarkable effort in the present circumstances when all materials

such as cement and steel, and even nails, are scarce. It was, of course, necessary with this speed of erection to leave in most of the shutter props to carry the weight of successive floors until the concrete had hardened sufficiently. At one time fourteen floors were shuttered and propped. No special shuttering was used. The props were of unwrought timber. The quantities of timber employed were more than 15,000 cu. ft. of 1-in. boards, 22,500 cu. ft. of 3-in. planks, and 300,000 ft. of props. The total area shuttered was about 630,000 sq. ft. The concrete in the reinforced members contained 580 lb. of ordinary Portland cement per cubic yard. The progress of the work is shown in *Fig.* 7.

The plant employed included two 10½-cu. ft. tilting-drum mixers, one 8¾-cu. ft. mixer, and two travelling mast-cranes. Each crane weighed about 37 tons and could lift 30 cwt. at 66-ft. radius to a height of 90 ft., or 3 tons at 33-ft. radius to a height of 137 ft. They were mounted on tracks at the back of the building, one on each side of the central tower, and so were able to distribute concrete to the whole of the site. The cranes were electrically driven, and owing to the frequent cuts in the mains power-supply during the droughts in recent years, it was necessary to install a 100-kva. Deisel generating-set on the site.

The architect for this hospital, which is one of many similar buildings being erected in Spain, is Don Martin José Marcide, the consulting engineer for the structural work is Don Carmelo Monzón y Repáraz, and the contractors are Eguinoa Hermanos.

Long Precast Prestressed Concrete Beams.

In this journal for August, 1950, page 296, a test of a precast prestressed concrete girder 48 ft. long is described. The beam, which was one of several required for a railway bridge of 43-ft. 6-in. span, was made in a factory by the system in which the wires of 0·2 in. diameter are stretched before the concrete is cast around them. Similar precast prestressed concrete beams of greater length, but with wires of 0·08 in. diameter, were cast in July, 1949, by the Concrete Development Co. at their factory at Iver, Bucks. Some of these beams are 53 ft. 6 in. long and are the main beams in the roof of a garage at Hatfield, and others, 56 ft. long, are in the roof of a part of the factory at Iver.

Conversion Factors.

An addendum to British Standard No. 350 (1944), "Conversion Factors and Tables", has recently been issued and includes definitions of French units of force (sthene), pressure (pieze), and heat (thermie), and of the metric carat, the legal measure in Great Britain. Additional data of interest to civil and structural engineers include the conversion of cubic metres to acre-feet, and pounds per square foot to kilograms per square metre, and conversion factors relating to atmospheric pressure, thermal conductivity, conductance and flow, and traffic units. The table of linear measure (British to metric units) has been extended to 1000 ft., and examples are given showing how the use of the tables can be extended. An index to the data in the Standard and addendum is a useful addition. The addendum is issued by the British Standards Institution.

Torsion in Continuous Structures.

By ALBIN CHRONOWICZ.

THE flexural stiffness S of a member subjected to bending is defined as the bending moment applied at one end that produces unit rotation at that end, and is $\frac{4EI}{l}$ if the far end is fixed and $\frac{3EI}{l}$ if the far end is hinged. Similarly, the stiffness of a member subjected to torsion can be defined as the twisting moment M producing unit rotation between two sections of the member, one section being subjected to the twisting moment and the other providing the torsional resistance. Referring to *Fig.* 1, $M = M_A + M_C$. If C is the modulus of rigidity of material, θ the rotation of section B relative to sections A and C, and I_0 the polar moment of inertia, then $M_A = \frac{C\theta I_0}{nl}$ and $M_C = \frac{C\theta I_0}{(1-n)l}$. Therefore M, which equals $M_A + M_C$, is $\frac{C\theta I_0}{(1-n)nl}$. Substituting $\theta = 1$, the torsional stiffness S_T at B is $\frac{CI_0}{(1-n)nl}$. In the special case when $n = \frac{1}{2}$, S_T is $\frac{4CI_0}{l}$.

Since the torsional stiffness will be compared with the flexural stiffness, it is convenient to express C in terms of E which is assumed to be constant and can be omitted from the calculations. Assuming Poisson's ratio for concrete to be 0·15, C is about $0{\cdot}4E$. Also the effective polar moment of inertia can be expressed as αAb^2, where α is 0·1 for a square of side b and 0·4 for a rectangle the ratio of the length of the sides of which are b to $4b$; A is the area of the cross-section. Hence S_T is $\frac{0{\cdot}4\alpha Ab^2}{(1-n)nl}$, and, for $n = \frac{1}{2}$, S_T is about $\frac{1{\cdot}5\alpha Ab^2}{l}$.

The ratio of the length of the sides of a rectangular cross-section subjected to torsion should not be more than 1 to 4. The flanges of tee-beams and ell-beams and any transverse members restraining the member in torsion should be ignored. No allowance is made for the reinforcement as its influence is not great and the amount of reinforcement is not usually known beforehand.

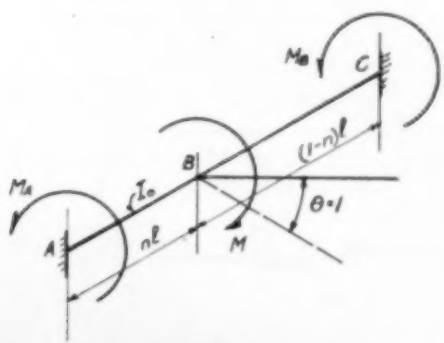


Fig. 1.

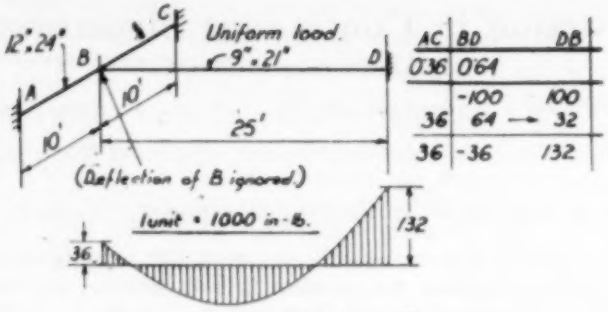


Fig. 2.

Examples.

EXAMPLE No. 1 (*Fig.* 2).—Assume that the fixed-end bending moments at B and D are each equal to 100,000 in.-lb. The stiffness factors are then:

For AC: $S_T = \frac{1{\cdot}5 \times 0{\cdot}2 \times 2 \times 1}{20} = 0{\cdot}03 =$, say, 1 unit

For BD: $S = \frac{4(E)I}{l} = \frac{4 \times 0{\cdot}75 \times 1{\cdot}75^3}{12 \times 25} = 0{\cdot}053 = 1{\cdot}77$ units

$\Sigma S = 2{\cdot}77$ units

Hence the moment-distribution factor α_{BD} for BD is $\frac{1{\cdot}77}{2{\cdot}77} = 0{\cdot}64$. The calculation of the resultant bending moments can be carried out by the moment-distribution method as in *Fig.* 2, which also gives the bending-moment diagram.

EXAMPLE No. 2 (*Fig.* 3).—Assume that the fixed-end bending moment at B is 100,000 in.-lb. Then, as in Example No. 1, $S_{Tx} = S_{Ty} = 0{\cdot}03 =$, say, 1 unit; $S_{AB} = S_{CD} = \frac{3 \times 0{\cdot}75 \times 1{\cdot}75^3}{12 \times 10} = 0{\cdot}1 = 3{\cdot}3$ units; $S_{BC} = 4{\cdot}4$ units; and $\Sigma S = 8{\cdot}7$ units. The moment-distribution operations and bending-moment diagram are given in *Fig.* 3.

EXAMPLE No. 3 (*Fig.* 4).—Assume that the fixed-end bending moment at A

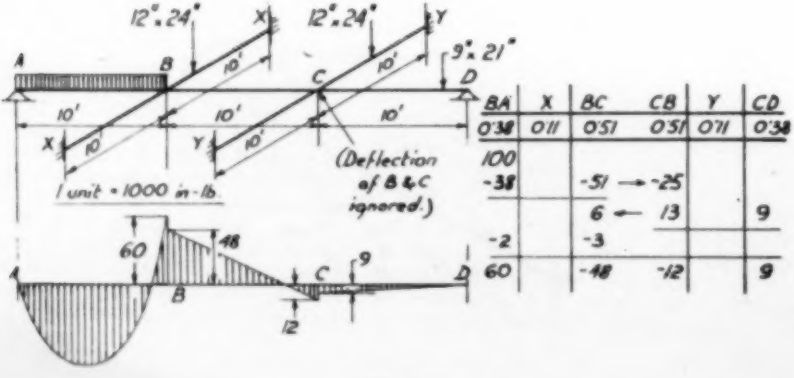


Fig. 3.

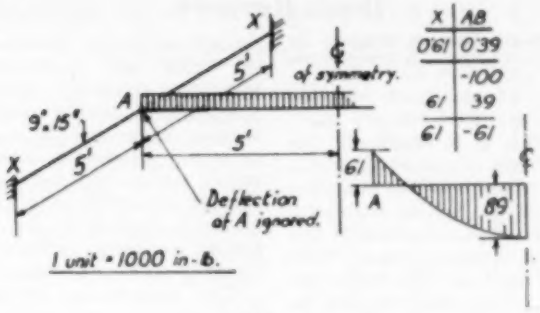


Fig. 4.

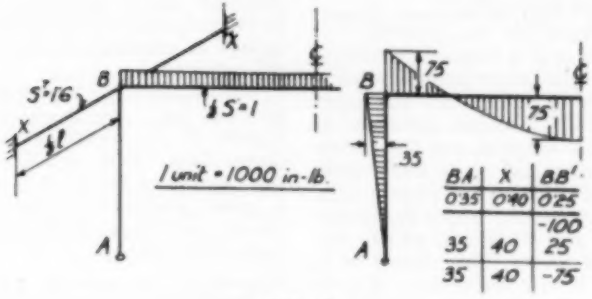


Fig. 5.

is 100,000 in.-lb. Then $S_{Tz} = \frac{1{\cdot}5 \times 0{\cdot}167 \times 0{\cdot}94 \times 0{\cdot}56}{10} = 0{\cdot}0132 =$, say, 1·6 units. Due to symmetry, $\frac{1}{2}S_{AB} = \frac{2 \times 0{\cdot}5 \times 1}{12 \times 10} = 0{\cdot}0083 = 1$ unit, and $\Sigma S = 2{\cdot}6$ units.

EXAMPLE No. 4 (*Fig.* 5).—Assume that the fixed-end bending moment at B is 100,000 in.-lb. By calculations similar to those in the previous examples, $\Sigma S_B = 4$ units.

NOTE.—Some of the data in the foregoing evaluation of the torsional rigidity of reinforced concrete members is based on the research by Professor W. T. Marshall and Mr. N. R. Tembe (" Experiments on Plain and Reinforced Concrete in Torsion ", Structural Engineer, November, 1941). The idea of identity of angle of twist and angle of rotation is also the basis of the consideration of space frames by Dr. J. L. Matheson (" Moment Distribution applied to Rectangular Rigid Space-Frames ", Journal of the Institution of Civil Engineers, January, 1948). The work of Professor Anderson in the United States is also acknowledged.

Book Reviews.

"A Course of Reinforced Concrete Design." By Thomas J. Bray. Second edition. (London: Chapman & Hall, Ltd. 1950. Price 30s.)

THE first edition of this book was reviewed in this journal for February 1947, and the new edition is substantially the same with the addition of a short appendix and one chart to show how the contents can be related to the British Standard Code of Practice of 1948. In view of the author's awareness of the existence of this Code, it is a pity that in this book the D.S.I.R. code of 1934 is still referred to as the "new" code. This is misleading to the reader.

"Concrete Fences." By A. M. Pennington. (London: Concrete Publications Ltd. 1950. Price 6s.)

THE author, who is a concrete products manufacturer with many years of experience, describes in full detail the most suitable materials, various methods of manufacture and erection, and the design of many common and some uncommon types of concrete fences for all purposes. A feature of the book, which comprises 64 pages and is well illustrated, is the many practical hints. This should be a useful work not only for makers of concrete fences but for local authorities, public utilities, architects, consulting engineers, and others responsible for the erection of fences. The subjects dealt with include proportions of concrete, moulds, reinforcement, inserts for fixtures, estimating quantities, and erecting fences. The types of fences described are three-wire, seven-wire, chain-link, woven-wire, barbed-wire, post-and-tube, post-and-bar, post-and-slab, post-and-block, "crash" fences, close-boarded fences with concrete posts, stub posts, race-course fences, chain-fences, ornamental fences, and gravel boards. The structural design of posts is described.

"'Hütte' Des Ingenieurs Taschenbuch." Vol. III, Part 1, Bauingenieurwesen. (Berlin: Wilhelm Ernst & Sohn. 1950. Price 14 D.M.)

THE new edition of Part 1 of this standard German reference book deals with the theory of structures, principles of design, and bridges. The section on theory of structures gives in compact form data for most types of statically-determinate and indeterminate structures met with in practice. Notes have been added on the calculation of circular beams and on beams on elastic supports, and a new theory of buckling is outlined. The second section is divided into chapters on brick and masonry construction, structural steelwork, reinforced concrete design, and timber construction. The section on reinforced concrete includes notes on prestressed concrete, thin prismatic structures, and precast concrete. Special attention is given to graphical methods applied to the design of reinforced concrete sections subjected to bending with and without axial forces.

The section on bridges deals with steel, concrete, and timber bridges. This chapter has been completely revised and includes many excellent examples of bridges of different types and spans with notes on structural and æsthetic considerations.

The authors have succeeded in compressing into 455 pages an exhaustive survey of the design of structures and design data. Although the type is small, the reading of the book is facilitated by a great number of clear illustrations which are particularly helpful in the section on bridges.

"Zehnteilige Einflusslinien für durchlaufende Träger." By G. Anger. Volume I. Sixth Edition. (Berlin: Wilhelm Ernst & Sohn. 1949. Price 15 D.M.)

As the title implies, this book of over two hundred pages gives, in the German language, data for the construction and application of influence lines for continuous beams divided into tenths, the ordinates being more closely spaced than in many other standard works. Formulæ derived from the theorem of three moments enable common cases of continuous beams of constant moment of inertia to be solved rapidly. Approximate methods of solution are described for beams of varying moment of inertia.

Books Received.

"A.S.T.M. Standards on Mineral Aggregates, Concrete, and Non-bituminous Highway Materials. —Specifications, Methods of Testing, and Definitions." Second Edition. 1950. (Published by the American Society for Testing Materials. 1916 Race Street, Philadelphia 3, Pa. Price 2.25 U.S. dollars.)

University of Illinois Bulletins. **"Lectures on Foundation Engineering."** By A. E. Cummings. (December, 1949; Price 1 U.S. dollar.) **"Moments in Two-way Concrete Floor Slabs."** By C. P. Siess and N. M. Newmark. (February, 1950. Price 0.60 U.S. dollar.) **"Studies of Highway Skew Slab-Bridges with Curbs. Part II: Laboratory Research."** By M. L. Gossard, C. P. Siess, N. M. Newmark, and L. E. Goodman. (February, 1950. Price 0.45 U.S. dollar.) Obtainable from the University of Illinois, Urbana, Illinois.

The Design of Deep Reinforced Concrete Beams and Blocks.

In a reinforced concrete beam, the depth of which is greater than, say, a quarter of the span, resistance must be provided against failure of the concrete at the supports and immediately below a concentrated load in addition to the ordinary resistance to bending and shearing forces. Tests made on deep beams show essential deviations from the distribution of stress that is assumed to occur in beams of common proportions. Many tests made at the Royal Institute of Technology, Stockholm, are described by Mr. H. Nylander and Mr. H. Holst in No. 2 of the Transactions of the Institute ("Några Undersökningar Rörande Skivor och Höga Balkarav Armerad Betong." In the Swedish language with a summary in English. Price 2 kroner from the Institute).

After the first cracks have formed, the stress distribution depends on the method of application of the load. When the load is applied to the top of the beam, the stress distribution is different from when the load is applied to the bottom. The results of the tests described are given in the form of design rules for beams which are subjected to loads applied to the top, but the rules for the permissible compressive stresses at the supports and below concentrated loads, and the stress distribution near a concentrated load, apply also to cases where the load is not applied to the top. Primary failure of the concrete in compression due to bending seldom occurs in deep beams, and this possibility may generally be ignored. Design must provide not only against failure but also against the formation of detrimental cracks, special reinforcement being provided for this purpose.

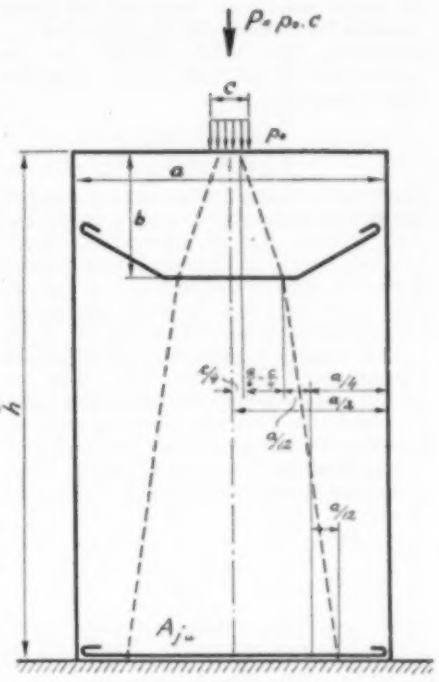


Fig. 1.

Table 1.—Maximum Horizontal Tensile Stress in Deep Block.

Coefficients of $\frac{P}{da}$.

$\frac{h}{a}$	$\frac{c}{a}$		
	0	0·1	0·2
Infinity	0·60	0·50	0·40
2·0	0·65	0·55	0·40
1·5	0·65	0·60	0·45
1·0	0·65	0·60	0·45
0·5	0·90	0·65	0·65

d = width of block.

The permissible compressive stresses recommended as a result of the tests are: (*a*) When the load is applied at a corner of the beam, the same stress as in an axially-loaded column if there is no danger of failure by buckling. (*b*) When the load is applied at a distance of three times the width of the support from a free edge, twice the stress in (*a*). If the reactions at the supports induce stresses exceeding the permissible stress, the strength of the beam can be increased by reinforcement to restrain the concrete from bursting.

The liability to failure in tension of a block supported on its entire underside and subjected to concentrated loads can be estimated from *Table* No. 1 which

gives the maximum horizontal tensile stress. The notation is given in *Fig.* 1. If the tensile stress exceeds the permissible value in shear, reinforcement, the amount of which should be based on the stress distribution after cracking, should be provided. The reinforcement for the prevention of splitting must resist the force computed from

$$S = \frac{P}{4}\left[\frac{a(h-2b)}{3b(h-b)} - \frac{e}{2b}\right],$$

which is derived from the assumption that the line of compressive stress is within the core of each part of the cracked block.

When providing reinforcement against failure in tension due to shear, a distinction must be made between continuous beams and freely-supported beams. *Figs.* 2 and 3 show typical lines of principal stresses, and the tests show that no special reinforcement is required at the supports if reinforcement in accordance with the recommendations given in *Fig.* 4 is provided in continuous beams. The basic area of the reinforcement is given by

$$A_{jv} = A_{jf} = \frac{P(l-e)}{8t_s\left(\frac{2h}{3k} + 0{\cdot}2b\right)},$$

where t_s is the permissible tensile stress in the shear reinforcement. For a load at the middle of the span, k is 1·05 for $\frac{l}{h} = 1$,

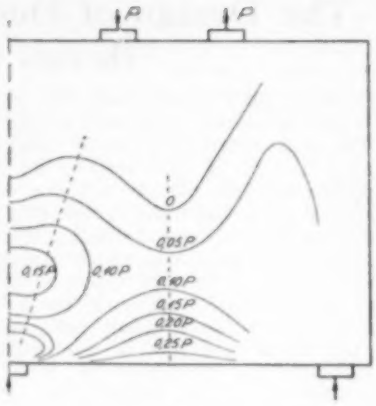


Fig. 2.

about 1·1 for $\frac{l}{h} = 2$, and about 1·15 for $\frac{l}{h} = 3$.

After the formation of cracks, a member resting freely on the supports acts as a strained trestle with tension rods, and the load-bearing capacity is dependent on the anchorage of the main tensile reinforcement. For this reason, the shear reinforcement should provide against the formation of detrimental cracks. The intensity of the principal tensile stresses in a simply-supported beam subjected to

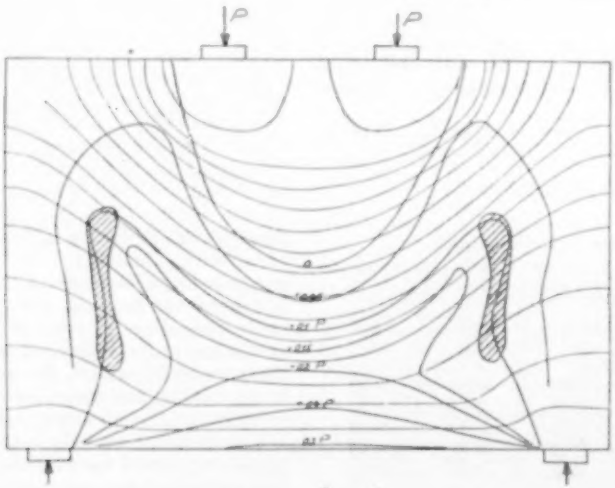


Fig. 3.—$\frac{l}{h} = \frac{4}{3}$.

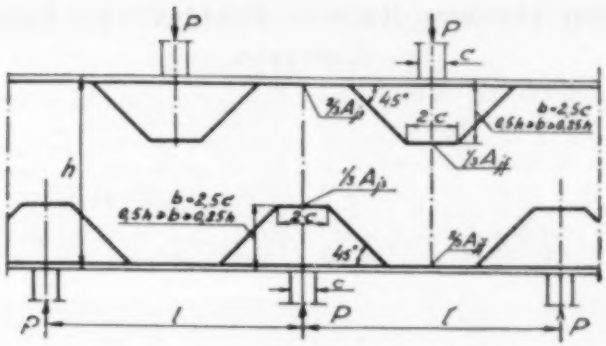


Fig. 4.

concentrated loads at the third-points of the span is shown in *Fig.* 3 $\left(\frac{l}{h} = \frac{4}{3}\right)$, and the values of the principal tensile stresses are given for various span-to-depth ratios in *Table* No. 2. As is seen in *Fig.* 3, the range where dangerous tensile stresses due to shear are not influenced by the bending cracks must be estimated, and *Table* No. 2 gives therefore approximate values. If the principal tensile stress in *Table* No. 2 exceeds 1·5 times the permissible tensile stress due to shear, the beam should be provided with shear reinforcement. The tensile force S to be resisted by the shear reinforcement and suggested permissible stresses in the reinforcement are also given in *Table* No. 2. The area of shear reinforcement required is $\frac{S}{t_s}$.

TABLE 2.—SHEAR REINFORCEMENT IN DEEP BEAM.

$\frac{l}{h}$	Principal tensile stress	Shear Reinforcement	
		Permissible stress t_s	S
1	$0{\cdot}9\beta$	$1{\cdot}00t$	$0{\cdot}45P$
2	$1{\cdot}2\beta$	$0{\cdot}80t$	$0{\cdot}95P$
4	$1{\cdot}5\beta$	$0{\cdot}55t$	$1{\cdot}10P$

d = width of block; $\beta = \frac{P}{dh}$; t = permissible stress in ordinary tensile reinforcement.

An Italian Concrete Mixer.

A NEW type of concrete mixer in use in Italy, and described in a recent number of "Il Cemento", is designed so that when in the loading position (*Fig.* 1*a*) the lip of the drum is about 18 in. from the ground so that it can be filled without a loading skip. When rotated into the discharging position (*Fig.* 1*b*) the height to the lip of the drum is about 3 ft. 6 in., so that the concrete can be discharged directly into most types of containers. The capacity of the drum is almost 9 cu. ft., which, it is claimed, is equivalent to an ordinary mixer of 12 cu. ft. capacity, since the dry materials are placed separately in the rotating drum and not all at once as when the drum is charged from a loading skip.

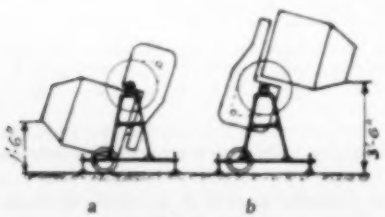


Fig. 1.

Replacing Masonry Railway Bridges with Reinforced Concrete.

MANY old masonry bridges on the Italian railways have been replaced in recent years by reinforced concrete structures. Two important factors in this connection are the increase of 30 per cent. to 50 per cent. (depending on the span) in the live loads, and the provision of lighter structures so that the foundations of the old masonry structures could be used without expensive strengthening. Whereas before the war the greatest span of reinforced concrete girder bridges for railways in Italy was about 40 ft. for simply-supported beams and 60 ft. for continuous beams, the corresponding spans are now 82 ft. and 145 ft. respectively, while bridges with ribbed-slab decks have been built up to 56 ft. span.

An example of a structure designed for a heavier load on existing foundations is the viaduct at Desenzano, near Lake Garda, shown in *Fig.* 1 (reproduced from "Edilizia Moderna"). The viaduct comprises sixteen independent portal frames, each pair of contiguous posts bearing on one of the old foundations, the pressure on which is now only about half that imposed by the old masonry arches.

Fig. 1.—Desenzano Viaduct, Italy.

The need to use foundations that cannot economically be strengthened has led to the adoption of light reinforced concrete bridges of types that in the past were not considered advisable for railways because of the dynamic action of large live loads predominating over the static loads. Now open-spandrel reinforced concrete arches have been constructed with the depth at the crown less than 2 per cent. of the span. In one bridge the depth at the crown is 3 ft. 6 in. and the span is 197 ft.

B.S. CODE OF PRACTICE (CP. 114–1948)

FOR REINFORCED CONCRETE

Explanatory Handbook now Available

AN "EXPLANATORY HANDBOOK ON THE BRITISH STANDARD CODE OF PRACTICE FOR THE STRUCTURAL USE OF NORMAL REINFORCED CONCRETE IN BUILDINGS", by W. L. SCOTT, M.INST.C.E., W. H. GLANVILLE, C.B.E., D.SC., M.INST.C.E., and F. G. THOMAS, PH.D., B.SC., M.INST.C.E., is now ready.

The work follows the same lines as the well-known Handbook on the D.S.I.R. Code by Scott and Glanville, and is indispensable to reinforced concrete designers. **The Code is printed in its entirety.** 128 pages, 25 illustrations, 51 tables.

Price 9*s.*; by post, 9*s.* 6*d.* In Canada and U.S.A., 2·10 dollars.

CONCRETE PUBLICATIONS LIMITED

14 DARTMOUTH STREET, LONDON, S.W.1, ENGLAND

Concrete Turbine Casings for Hydro-Electric Works.

In the course of a lecture on hydro-electric development delivered by Mr. Geoffrey F. Kennedy, M.A., M.I.E.E., M.I.Mech.E., at the Royal Society of Arts (and published in the Journal of the Junior Institution of Engineers), the question of steel and concrete casings or settings for turbines in hydro-electric works was discussed.

The type of setting used influences the depth to which excavation must be taken and the overall dimensions of the power-station building. The type of setting depends primarily on the head of water under which the turbine operates. *Fig.* 1 shows the settings which are used for different sizes of turbines of various powers and heads. For heads exceeding 350 ft. the spiral casing is generally of cast steel; between 350 ft. and 110 ft. it is of cast steel or steel plate; from 110 ft. to about 38 ft. it is either steel plate or concrete; below 38 ft. the casing is generally of concrete. The problem of the type of setting to use arises generally therefore only with lower-head installations. [A typical scroll casing in reinforced concrete for a low-head plant is that at the hydro-electric works at Pitlochry, a cross-section through which is given on page 62 of this journal for February, 1949. The shuttering for the turbine draught-tubes of Clunie generating station is given on page 61 of the same number.]

The advantages of a steel-plate spiral casing are that its construction is relatively independent of conditions at the site, which is an important point for works in remote parts, and it is generally cheaper than reinforced concrete for high heads, but, because of its circular cross-section, a steel casing takes up more space than a concrete casing and the turbines must therefore be separated by a greater distance than is possible if a concrete casing is provided. With a steel casing there is the possibility of vibration and the consequent need to tie the casing to a mass of concrete, which is simple with a small turbine which can be covered with concrete. With a large turbine there is appreciable expansion in the diameter of a steel casing under the full head, and the question arises whether to cover the casing with concrete while it is under pressure or before the pressure is applied. In the first case there is a risk that when the pressure is relaxed the casing may contract and leave a gap between the casing and the concrete, which in time may lead to corrosion of

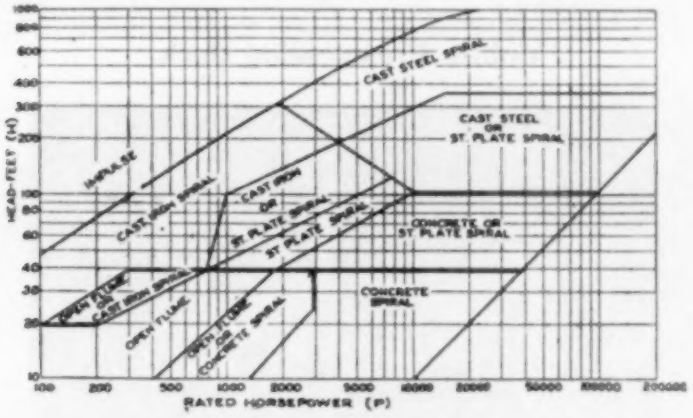
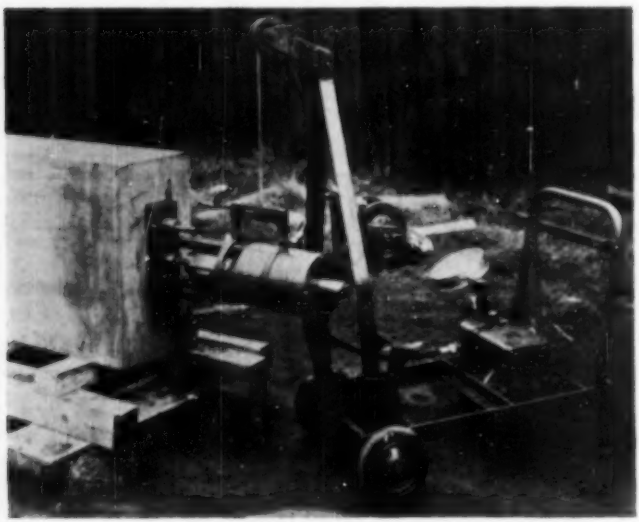


Fig. 1.—Power and Head of Turbines for Settings of Various Construction.

the steel. If the casing is covered with concrete while empty there is a possibility that the expansion of the casing when the pressure is applied may crack the concrete. In the author's opinion it is better to leave large steel-plate spiral casings open so that they are free to expand and contract, but they must then be well supported to reduce vibration.

A reinforced concrete casing is suitable for heads up to about 110 ft., but for larger heads the reinforcement becomes so congested that it is difficult to compact the concrete. The shuttering of a spiral casing is complex, and it is essential to have sufficient suitable timber for the construction of practically the whole of the shuttering since repeated uses are generally impossible. Because timber is readily available, reinforced concrete casings are common in Scandinavia. A reinforced concrete casing results in the turbines being placed more closely together, which enables a reduction to be made in the length of the power-station building. Although the cost of a reinforced concrete casing may, for the highest heads for which they are suitable, exceed that of a steel casing, the total cost of a station with reinforced concrete casings may be lower owing to the smaller building.

Mobile Prestressing Jack.



THE accompanying illustration shows a self-contained mobile jack for use in the Lee-McCall system of prestressed concrete, which was described in this journal for April, 1950 (page 127). The machine, which is mounted on a trolley, embodies an hydraulic pump serving a jack of 42 tons capacity. The jack can be raised or lowered by the winch on the trolley thereby enabling high-tensile steel-alloy bars to be tensioned at any level between 10 ft. above and 10 ft. below the level of the trolley. Since the jack thrusts against the end of the member being prestressed, the thrust can be applied at almost any angle.

Distributing Concrete at the Royal Festival Hall, Festival of Britain.

Figs. 1 and 2 show the distribution by pump and pipeline of the concrete at the concert hall now under construction at the Festival of Britain, in London. Most of the cast-in-situ concrete is placed by concrete pumps. As the height of the building exceeds 100 ft., it was necessary to install a relay system of pumps to carry the concrete to the upper parts. *Fig.* 1 shows the batching and mixing plant feeding the first pump, which is on the ground and pumps concrete through a horizontal pipe-line and then up the outer face of the wall to a height of 45 ft. to 50 ft. The pipe-line then passes through the wall and proceeds around the auditorium, as seen on the right-hand side of *Fig.* 2, and discharges into a container which in turn discharges into the feed-hopper of the second pump. In *Fig.* 2 the feed-hopper is in the bottom right-hand corner and the pipe-line from the second pump is seen extending to the left. The concrete is discharged from this pipe-line into a hopper on the scaffolding about 50 ft. higher than the pump. Wheelbarrows are filled from the hopper. In the first stage the pumping distance is 350 ft., which includes the length of the horizontal and vertical pipes and the bends, and is equivalent to a horizontal pumping distance of 700 ft. The pumping

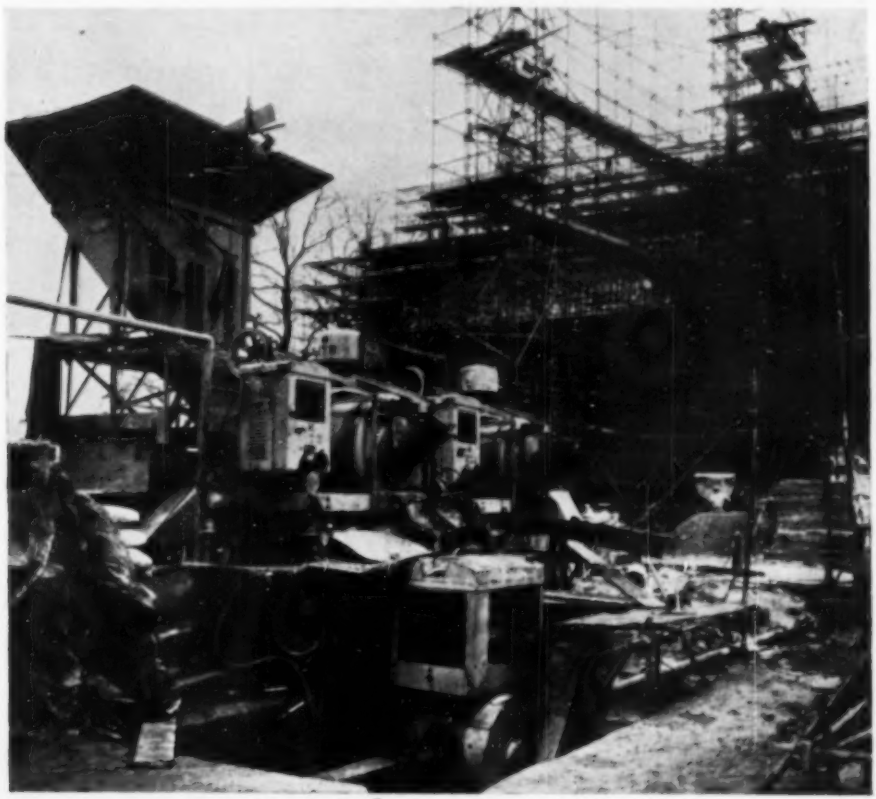


Fig. 1.—Mixing Plant and Pump at Ground Level.

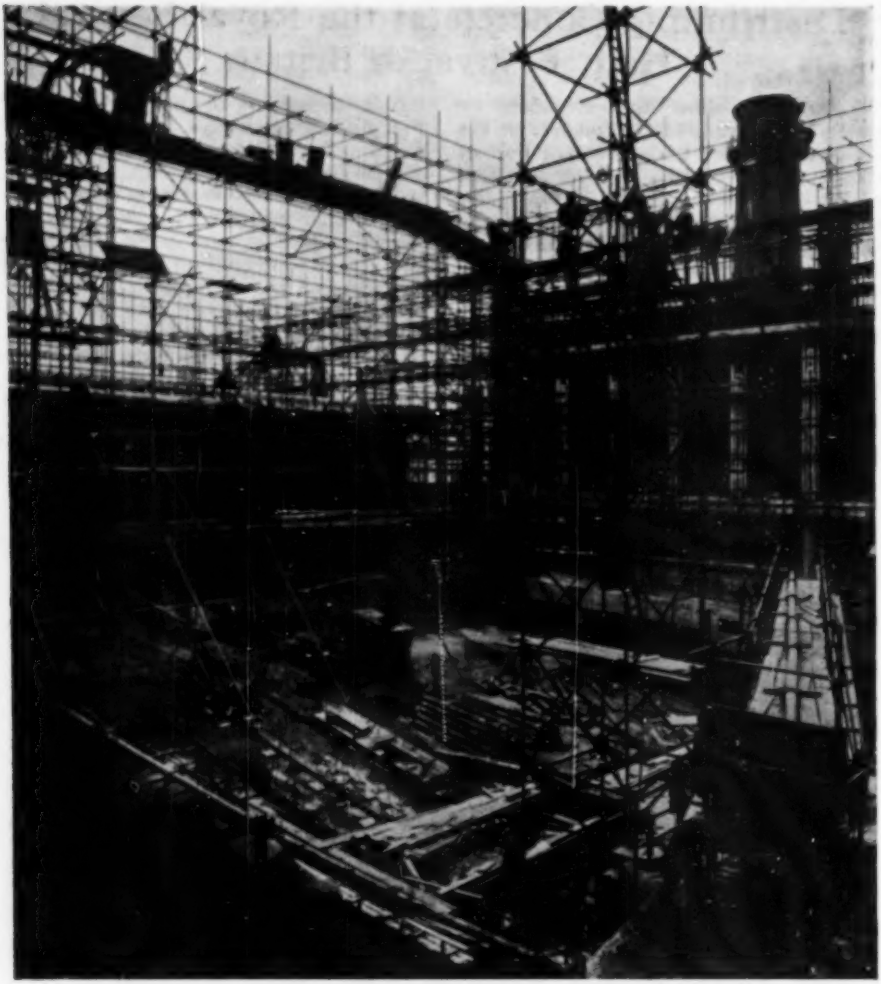


Fig. 2.—Pump about 50 ft. above Ground and Pipeline to Roof.

distance in the second stage is 110 ft., which is equivalent to a horizontal pumping distance of 450 ft.

The architect for the hall is Mr. Robert H. Matthew, A.R.I.B.A., chief architect of the London County Council, directing a team of architects. The consulting civil engineers are Messrs. Scott & Wilson. The main contractors are Messrs. Holland & Hannen and Cubitts, Ltd. The concrete pumps were supplied by Messrs. Blaw-Knox, Ltd.

Specialities Allied to—
CONCRETE & BUILDING PRODUCTS
including Accelerators, Retarders, Hardeners, Waterproofers, Oilproofers, Cement Paints, etc.
For full particulars please write
ALLIED BUILDING COMMODITIES
LITTLE ROYD, HUDDERSFIELD.

STEEL FORMS

Consulting Engineers:
SCOTT & WILSON, M/M.I.C.E.

Architects:
POWELL & MOYA, A/A.R.I.B.A.

Contractors:
HOLLOWAY BROTHERS (LONDON), LTD.

THE SYSTEM OF SHUTTERING

USED

IN THE CONSTRUCTION OF THE

CITY OF WESTMINSTER

PIMLICO HOUSING SCHEME

(Director of Housing: JOHN HUGHES, B.Arch.F.R.I.B.A.)

A. A. BYRD & COMPANY, LTD.

210, TERMINAL HOUSE, GROSVENOR GARDENS — LONDON, S.W.1

'Phone - - - SLOane 5256
'Grams - - - Byrdicom, Wesphone, London

STEEL REINFORCING BARS

"Stribar" Reinforcement is the backbone of multitudinous ferro-concrete structures. The "Stribar" service of ready-for-use reinforcement, cut to length and, if required, hooked and bent, is being maintained as far as present abnormal conditions permit. Deliveries from warehouse stocks in the London area cannot always be guaranteed, but by telephoning Sloane 4533 the latest position can always be ascertained.

THE UNITED STEEL COMPANIES LTD

UNITED STRIP & BAR MILLS · THE ICKLES · SHEFFIELD

Branch of The United Steel Companies Limited *Telephone : Sheffield 41011 · Rotherham 5421*

LONDON : 8-10 Grosvenor Gardens, S.W.1 *Telephone : Sloane 4533*

S.78

Long-Span Hangars at Chicago.

A NEW hangar (*Figs.* 1 and 2) at Chicago Airport is 175 ft. long and comprises two spans of 257 ft. each measured in the clear. The principal dimensions are given in *Fig.* 1. The ribs are designed as flexible arches and the slabs as a membrane. The slab is 3½ in. thick except for a distance of 15 ft. from each abutment where it increases to 6 in., and on either side of each rib where in a distance of 4 ft. it increases to 5½ in. The stiffening ribs are at 28-ft. 11½-in. centres and alternate ribs are 22 in. wide. For constructional purposes intermediate ribs rib. Nevertheless the stresses due to the secondary effects mentioned are about 90 per cent. and 110 per cent. of those at the springing and crown respectively due to the bending moment caused by the live load. If the slab were placed at either the top or bottom of the rib it would become the compression flange over part of the arch, and stresses would be induced which the slab would be unable to resist without being much thicker. The principle of flexible ribs, on which this roof is designed, necessitates a close analysis of the stresses for which

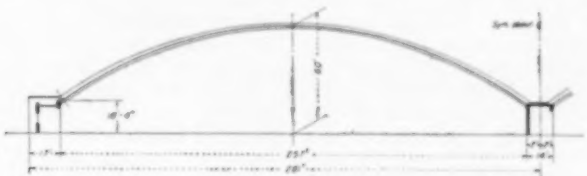


Fig. 1.

Fig. 2.

are built as two 10¾-in. ribs with ½ in. space between. The ribs are shaped to follow the line of thrust of the dead load. The absence of a dead-load bending moment lessens distortion due to plastic flow under long-time loading and enables smaller ribs to be used. The depth of each rib is 38 in. at the crown and is almost constant from the crown to the first and third quarter-points, from where it increases to 50 in. at the springings, the variation resulting in almost constant stresses in the concrete. Since the stresses due to shrinking, change of temperature, rib-shortening, and yield of the abutments increase with increase in the moment of inertia, the moment of inertia is kept as small as possible by placing the slab at about the neutral-axis of the the ordinary elastic theory of arches is inadequate as the stresses are underestimated thereby. Account was taken of the eccentricities of the thrusts about the deflected position of the rib. Since the curvature of the rib varies, a direct mathematical solution was not practicable and the effect of the deflections was evaluated by a method of successive approximations.

Tests on a model showed that a pressure of 21 lb. per square foot and a suction of 10 lb. per square foot at right-angles to the surface of the roof are induced with a wind of 90 miles per hour. The differences in temperature were assumed to be ± 70 deg. F. between the top and bottom of the ribs, and an overall change of ± 30 deg. F. in the ribs which,

Fig. 3.

as is the slab, are insulated. The proportion of the thrust in the arch carried by the slab is indeterminate, and limiting assumptions were made. For example, in calculating the amount of tensile reinforcement required in the ribs due to bending, it was assumed that the thrust was shared between the rib and the slab but that the rib resisted all the bending. To ensure sufficient compressive strength, the ribs were then assumed to resist the whole thrust.

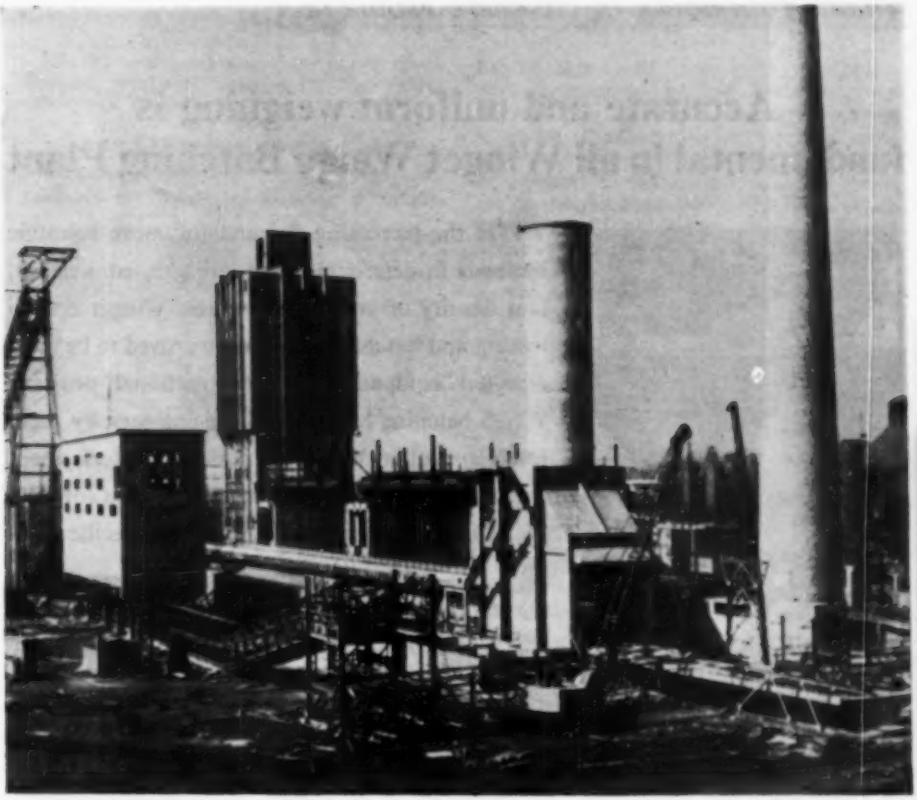
Reinforced concrete was selected because, among other reasons, non-fireproofed steel would not cost less and fireproofed steel framing would be considerably more costly. The foundations of the abutments are on medium-hard yellow-brown clay, the pressure on which is 1·2 tons per square foot under dead load and 1·6 tons per square foot under total load; a pressure of 2·2 tons per square foot was permitted under unbalanced construction loads.

The roof is of rapid-hardening cement concrete and was built in the winter of 1946–7. Each of the two spans was built in three sections each 58 ft. long. Timber centering with plywood sheeting was provided for this length. Between each use the centering was lowered about 2 ft. to clear the undersides of the rib when travelling to the next position. Ratchet-jacks were used for the main vertical movement, but screw-jacks were used for the final adjustment. *Fig.* 3 shows the centering removed from the first span and ready to travel sideways for use in the adjacent span. The foregoing notes and illustrations are from an article in a recent number of "Engineering News-Record."

WASHED
BALLAST, SAND, SHINGLE &
Crushed Aggregate for Reinforced Concrete.

WILLIAM BOYER & SONS, LTD.
Sand and Ballast Specialists,
IRONGATE WHARF,
PADDINGTON BASIN, W.
MEMBERS OF B.S. & A.T.A.

DELIVERED DIRECT TO ANY CONTRACT BY MOTOR LORRY.
Quotations on Application.
Telephone: Paddington 2024 (3 lines).



A general view of the new coking plant at the East Greenwich Gasworks, designed and constructed by Messrs. Simon-Carves, Ltd., for the South Eastern Gas Board. All the structures shown are supported on Simplex Concrete Cast-in-Situ Piles.

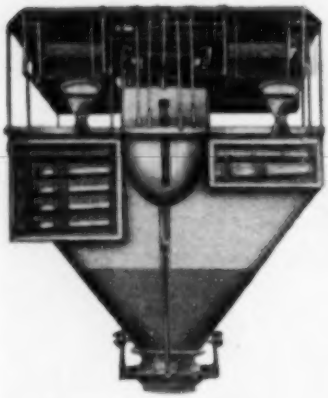
SIMPLEX CONCRETE PILES LTD.

25 BRECHIN PLACE, SOUTH KENSINGTON, LONDON, S.W.7

Telephone: Fremantle 0035-6

WINGET TECHNIQUES IN CONCRETE PRODUCTION

Accurate and uniform weighing is fundamental in all Winget Weigh Batching Plant



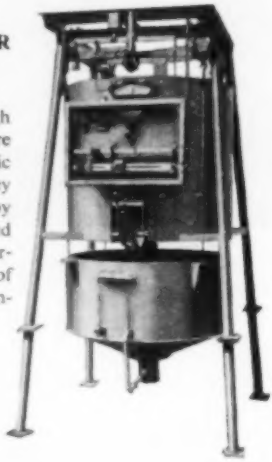
WITH the increasing demand for more scientific methods in determining the strength, consistency, and density of concrete mixtures, Winget central mixing and batching plants have proved to be most essential equipment on constructional projects. Weigh batching has enabled the engineer, by accurately controlling the proportioning of water, cement and aggregates, to produce with certainty a concrete of desired strength and strictly to specification.

THE WINGET-JOHNSON CONCENTRIC WEIGH BATCHER reduces batch cycle time, pre-mixes, and pre-shrinks.

The Winget-Johnson Concentric Weigh Batcher pre-mixes all ingredients as they flow to the mixing unit; provides pre-shrinkage and elimination of cement dust; gives faster discharge to mixer; eliminates gumming at mixer opening; and weighs cement on a separate scale.

THE WINGET-JOHNSON WATER WEIGH BATCHER handles mixing water at top speed

Winget-Johnson Water Weigh Batchers measure water more accurately than by volumetric measurement or metering. They can be checked for calibration by test weights, and are not affected by temperature variations. Overhead reservoir permits heating of water and makes batching independent of line pressure.



This 120 cu. yd. Winget-Johnson Step-by-Step Bin incorporates the weighing systems described above, as well as many other Winget quality control systems. It is producing concrete for the Claerwen Dam, N. Wales. (Contractors: Edmund Nuttall Sons & Co. (London) Ltd. With acknowledgements to the Birmingham Corporation Water Department.)

Winget Weigh Batching Plant and other Civil Engineering Equipment are supplied for such projects as: Owen Falls (Uganda), Yenda Nova Dam, Grimsel Dam, Maroetai Dam, Prescott Reservoir. Ask for Publication No. 100.

Registered Trade Mark

Winget

CONCRETE PLANT SPECIALISTS

WINGET LTD ROCHESTER KENT ENGLAND

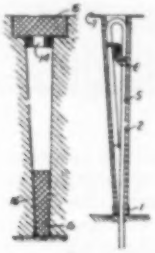
Tel: Strood 7276 (3 lines) Telegrams: Wingetism Rochester

Patents Relating to Concrete.

[NOTE.—Publication of these patent specifications has been delayed by the Patent Office due to the war.]

Expansion Joints.

Expansion joints for road and runway surfaces are made by forming a vertical break in the unhardened surface material by means of collapsible shuttering, removing the shuttering when the material has hardened and partly filling the break with a material of low viscosity. As shown in *Fig.* 1*b*, the shuttering comprises a metal channel (1), supporting rectangular metal side sections (5) to which are welded ell-shaped members (6) forming an interlocking device which limits the extent to which the sides (5) can be forced apart when wedge-shaped members (2) are driven through slots in the channel (1), and a metal capping (7). The shuttering is positioned so that the capping strip (7) is below the level of the finished road or runway and, after spreading the concrete in the normal way, the capping strip (7) with its superimposed layer of concrete is removed and the concrete smoothed over to form a ledge in the walls of the joint, *Fig.* 1*a*. When the concrete (16) has set, the wedge sections (2) are withdrawn, thus allowing the sides (5) to collapse and to be removed, whereupon the lower portion of the joint is filled with bitumen (13) of a plasticity such that it will easily flow at the lowest temperature. A sealing strip



(*a*) (*b*)

Fig. 1.

COPPER STRIPS
for expansion joints

All Reinforced Concrete Engineers recognise the advantages of using copper strips for sealing joints in concrete work. Copper is ductile, will not crack under repeated bending, is non-corrosive and is unaffected by wet concrete. We specialise in the supply of perforated copper strips of all required lengths and widths for expansion joints, and shall be pleased to submit prices against detailed specification.

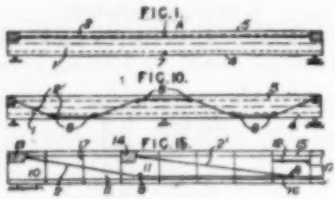
ALEX J. CHEETHAM LTD.
MORTON STREET • FAILSWORTH • MANCHESTER
Telephone: FAILsworth 1115/6

DS14

(14) is placed on the ledge formed by the removal of the capping strip (9) and bituminous sealing compound (15) poured on top of this strip. No. 594,103. C. E. Docker, June 26, 1945.

Prestressed Concrete Beams.

A beam of concrete, which may be reinforced, stone or metal, is prestressed by an initially straight tie, or ties, anchored to the ends of the body of the beam and arranged externally thereof, tension being applied to the tie by forcing it out of its straight-line condition until the displaced



part of the tie lies adjacent to the zone of the beam to be subjected to the maximum tension stresses. As shown in *Fig.* 1, the beam (1) is prestressed by a tie (2) which is displaced transversely at its mid-point A until the wire reaches below the hole (7) through which a holding-pin is inserted. The transverse displacement may be effected by applying force at two or more points (A), two or more holding pins being

AQUAREP
SEND FOR DETAILS
for 100% WATERPROOF CONCRETE
DAMP-PROOFING LTD.
DEPTFORD Tel. TIDeway 1486-7 LONDON, S.E.

STEEL TRENCH SHEETING
(Regd. design No. 850839)
Prompt Delivery
For the temporary lining of trenches and foundations. *Prices and full particulars on application to:—*
DORMAN LONG & CO. LTD., SHEET DEPT.
AYRTON WORKS, MIDDLESBROUGH
London Office: Terminal House, 52 Grosvenor Gardens, S.W.1
DORMAN LONG

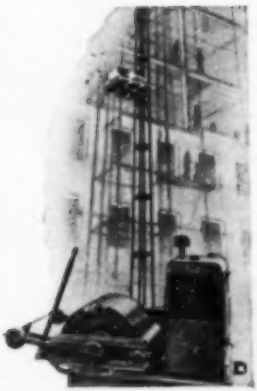
SGB

—the originators of tubular scaffolding!

...now offer

WICKHAM BUILDERS' HOISTS

...for immediate Hire or Sale!



- TAKES LESS TIME TO ERECT
- LOWER COST OF MAINTENANCE
- LONGER EFFECTIVE LIFE
- HEAVY DUTY SELF-ALIGNING BALL-BEARINGS FITTED TO DRUM AND DRIVE-SHAFT
- FABRICATED SIDE MEMBERS FOR GREATER STRENGTH AND DURABILITY, WHICH PERMITS ALSO THE QUICK REMOVAL OF THE DRIVE-SHAFT FOR SERVICE OR REPLACEMENT.
- QUICK ASSEMBLY MAST SECTIONS ELECTRICALLY WELDED THROUGHOUT.
- COUPLED TO DIESEL OR PETROL ENGINE OR TO ELECTRIC MOTOR.
- THE ENTIRE UNIT TOTALLY ENCLOSED IN STEEL HOUSING.

- STANDARD CAPACITIES

5/10 cwt. 10/15 cwt. 20/30 cwt.

Wickham Winches can be supplied separately.

NOTE: *ALL WICKHAM HOISTS & WINCHES are already fitted with the requisite Safety devices to comply with the very latest Building Regulations 1948 No. 1145. Test certificate is supplied with each machine. S.G.B. Hire Plant is maintained in first class condition by highly skilled mechanics, thus ensuring trouble free running, whilst in operation.*

SCAFFOLDING (GREAT BRITAIN) LIMITED

Plant Division: **MITCHAM, SURREY**
Telephone: MITCHAM 3400 (18 lines)
Telegrams: SCAFCO, MITCHAM

Branches at: ABERDEEN - BIRMINGHAM - BOURNEMOUTH - BRIGHTON BRISTOL - CAMBRIDGE - CARDIFF - DOVER - DUBLIN - DUNDEE - EDINBURGH EXETER - GLASGOW - HULL - LEEDS - LIVERPOOL - MANCHESTER - NEWCASTLE - NOTTINGHAM - OXFORD - PLYMOUTH - PORTSMOUTH SOUTHAMPTON - STOKE-ON-TRENT - SWANSEA

MISCELLANEOUS ADVERTISEMENTS.

Situations Wanted, 3d. a word: minimum 7s. 6d. Situations Vacant, 4d. a word: minimum 10s. Other miscellaneous advertisements, 4d. a word: 10s. minimum. Box number 1s. extra.

Advertisements must reach this office by the 23rd of the month preceding publication.

SITUATIONS VACANT. Reinforced concrete designers and detailers required by old-established firm of civil engineering contractors in Leeds. The positions are permanent and progressive to suitable men, and the work is varied and interesting. Write stating age, qualifications, experience, and salary required. Applicants selected for interviews will be provided with travel vouchers and reasonable out-of-pocket expenses. Apply in confidence to BOX 2400, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

SITUATIONS VACANT. Draughtsmen-Detailers and Draughtsmen with working knowledge of reinforced concrete are invited to apply to us for progressive and responsible positions which are now open in the Manchester and Birmingham area. Write, giving full details, to BOX C.E. 992 at 191, Gresham House, London, E.C.2.

SITUATION VACANT. Senior Reinforced Concrete Designer required for permanent staff of Consulting Engineer's Office in Westminster. Applicants must possess several years' experience in a responsible position in first-class reinforced concrete specialists' offices. Commencing salary £900 to £1,000 p.a. Applications, which will be treated as confidential, should give full details of age and experience. BOX 2411, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1

SITUATIONS VACANT. Steelwork designers and draughtsmen required at an early date for important works on several large generating stations. Position is of a permanent character. A full-scale superannuation scheme is in operation. Applicants are asked to send details of experience and scale of salary required, and to state when available for interview and explanation of duties in Manchester, to C. S. ALLOTT & SON, Consulting Civil Engineers, 1 North Parade, St. Mary's Parsonage, Manchester, 3.

SITUATIONS VACANT. Reinforced concrete designers and draughtsmen required at an early date for important works on several large generating stations. Position is of a permanent character. A full-scale superannuation scheme is in operation. Applicants are asked to send details of experience and scale of salary required, and to state when available for interview and explanation of duties in Manchester, to C. S. ALLOTT & SON, Consulting Civil Engineers, 1 North Parade, St. Mary's Parsonage, Manchester.

SITUATIONS VACANT. A large firm of reinforced concrete engineers will be requiring draughtsmen detailers and a reinforced concrete designer at their Liverpool drawing office which will be opening shortly. The posts offered are permanent. Please write, giving full details of experience and when available, to BOX C.E.204, at 191, Gresham House, London, E.C.2.

SITUATION VACANT. Senior reinforced concrete designer required in progressive Midland firm. Permanent pensionable post. Salary according to experience. Apply F. C. CONSTRUCTION CO., LTD., City Road, Derby.

SITUATION VACANT. Engineer-agent to take full charge of large civil engineering contract in S.W. Previous experience in similar capacity essential. Salary up to £1,500 p.a., according to qualifications and experience. Reply, stating name of previous employers, with dates, age, and very brief particulars of other qualifications, to BOX 2419, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

SITUATION VACANT. Required Deputy to Design Manager for engineering department in Birmingham. Should have all-round experience of reinforced concrete design and able to control staff. The minimum age is 32 years, and the post offered is permanent and progressive. Salary according to qualifications and experience. Five-day week and Pension Scheme in operation. Write, giving full details, to BOX C.C. 991 at 191, Gresham House, London, E.C.2.

SITUATIONS VACANT. Reinforced concrete designers, detailers and draughtsmen urgently required. Permanent positions. State age, experience and salary required. CLARKE, NICHOLLS AND MARCEL, Consulting Engineers, 21 Westbourne Grove, London, W.2.

SITUATION VACANT. Architectural draughtsman required with an experience of factory design. Applications to be sent, together with full details of experience and salary required, to BOX C.E.273, at 191 Gresham House, London, E.C.2.

SITUATIONS VACANT. Draughtsmen-detailers and draughtsmen with working knowledge of reinforced concrete are invited to apply to us for progressive and responsible positions which are now open in the Bristol area. Write, giving full details, to BOX C.E.271, at 191 Gresham House, London, E.C.2.

SITUATION VACANT. Chief engineer-agent for medium-size public works contractors doing interesting variety of unspectacular work. Experience of general civil, structural and reinforced concrete construction essential and knowledge of building advantageous. Pension and profit-sharing schemes. Full particulars of experience, qualifications, positions held and age, in writing only, to GRATTON WILSON, LTD., 13 Frederick Street, London, E.15.

SITUATION VACANT. We have a vacancy for a mechanical draughtsman used to factory maintenance. The post offered is progressive and in the London area. Five-day week and pension scheme in operation. Write, giving full details, to BOX C.E.272, at 191 Gresham House, London, E.C.2.

SITUATIONS VACANT. Senior engineer designers are required by a well-known firm of reinforced concrete specialists to take charge of branch drawing offices in Bristol, Manchester, Newcastle, Leicester Sheffield, and Glasgow. Designer-detailers are also required. BOX 2421, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

SITUATIONS VACANT. Reinforced concrete designers wanted for East Africa, and one for South Africa. Full details of experience, age, whether married or single, salary required, etc., to BOX D.N.O., c/o 95 Bishopsgate, London, E.C.2.

SITUATION VACANT. Works manager. Applications are invited for the appointment of works manager for a prominent firm of prestressed and precast concrete manufacturers in Surrey. Qualifications required are a thorough understanding of the scientific approach to modern methods of works management, including a comprehensive technical knowledge of concrete and its present-day uses, coupled with the ability to design and manufacture moulds in both timber and metal. An excellent opportunity for the right man for whom accommodation may be provided. Pension scheme in operation. Salary by arrangement. Write BOX 2424, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

SITUATIONS VACANT. The British Reinforced Concrete Engineering Co., Ltd., require several qualified designers with specialist experience for their Stafford and London offices. Five-day week, staff pension scheme, and canteen. Apply to B.R.C. ENGINEERING CO., LTD., Stafford.

SITUATIONS WANTED.

SITUATION WANTED. Reinforced concrete designer with sound theoretical knowledge (university degree), 20 years' experience in design, detail, and quantities, and capable and competent of working on his own initiative, seeks change. Expected salary £1,000 p.a. BOX 2415, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

PROFESSIONAL SERVICES. Reinforced concrete designer (University degree) with twenty years' experience undertakes to prepare complete design, working drawings, bills of quantities, and bending schedules for all types of reinforced concrete structures. Willing to help consultants and contractors requiring part-time assistance. BOX 2418, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

(Continued on facing page).

No timber is required, no carpenters' workshop on site. No obstruction beneath. For solid Concrete or Hollow Tile floor and roof construction. Instantly-adjustable up to 15 ft., adaptable for larger spans. Invaluable also for repair work. On hire from stock. Write or 'phone.

TRIANCO LTD. (D. 26)
Imber Court, East Molesey, Surrey
'Phone: Emberbrook 3300 (4 lines)

then used to constrain a length of tension wire to remain along the lowermost zone (4) of the beam, or two ties (2), one anchored at the ends of the beam and the other at points spaced from the ends of the beam, are each deflected at two points. The extent of the deflection may be such that the tie is brought outside the zone (4). The tie (2) may, as shown in *Fig.* 10, be stressed by transverse deflections requiring six holding-pins (8). An additional tie, similarly prestressed, may be anchored in the zone (4) and deflected transversely towards the zone (5). *Fig.* 15 shows an H-section beam made of separate blocks, the end blocks (10) carrying a cross bar (13) in which the end of the tie (2) is embedded. Some of the intermediate blocks (11) carry cross bars (14) for additional ties (2′), metal sleeved holes for holding pins (8) being provided. The ties (2) and (2′) each comprise light steel wires, four on each side of the central web. To facilitate the placing of the wires, one block (12) is made in two parts, (15) and (16), which are placed in position before the tensioning of the ties. Cement joints (17) are provided between the blocks (10) and (11) and the parts (15) and (16) and between the blocks (10) and (11) and the cross bars (13) and (14). The wires may be maintained in the deflected position by struts arranged between the top flanges of the beam, which may be specially formed to retain the struts in position, and the ties. A jack for tensioning the ties is described. No. 601,038. C. Wets. August 23, 1945.

MISCELLANEOUS ADVERTISEMENTS.

(Continued from facing page).

SITUATION WANTED. Representative, fully experienced, calling on public authority and private architects in London and Home Counties, with extensive connection, seeks permanent position. Information given in confidence. Box 2420, Concrete and Constructional Engineering, 14 Dartmouth Street, Westminster, S.W.1.

SITUATION WANTED. Chartered civil engineer, widely experienced in reinforced concrete engineering and contracting including sales and administration, is becoming available for a major executive position in the industry. Financial interest if desired. Suggestions in strict confidence to Box 2422, Concrete and Constructional Engineering, 14 Dartmouth Street, Westminster, S.W.1.

FOR SALE.

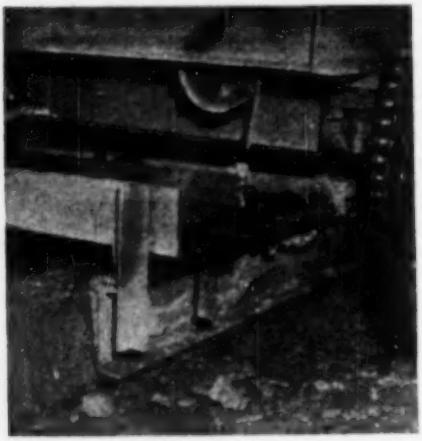
FOR SALE. ¼ in. thick pressed steel shuttering panels, 1 ft. 10 in. × 1 ft. 10 in. at 9*s.* each; 2 ft. 10 in. × 1 ft. 10 in. at 11*s.* 6*d.* each. Other sizes and moulds made quickly to specification. Special gutters and ironwork. E. Stephens & Son, Ltd., 58–64 Bath Street, London, E.C.1.

FOR SALE. New 2½-in. bore rubberised canvas suction hose with coiled rust-proofed wire insert in 12 ft. and 6 ft. lengths. 10*s.* and 5*s.* per length, carr. paid. Small orders C.W.O. please. Woodfield & Turner, Burnley. Telephone: Burnley 3065.

FOR SALE. Reinforcing rods. ⅜" diameter × 10/12 ft., in 1-cwt. bundles at £22 per ton f.o.t. ½" diameter straight stirrup wires in 1-cwt. bundles at £22 10*s.* per ton f.o.t. Orders accepted in rotation. S.B.S. Steel Company, 5 Victoria Terrace, Leeds, 3.

A Moving Side-Form for Concrete Roads.

THE accompanying illustration shows an attachment on the back of a travelling mixing, placing, and finishing plant which



is used instead of fixed side-forms for concrete roads. The concrete has a slump of 2 in. to 3 in. The machine, which straddles the road, is dragged forward at a rate of about 8 ft. per minute carrying with it the steel form for the vertical edge of the slab. When the machine is travelling about the site, the form is lifted to clear obstructions.

Contraction Joints in Roads.

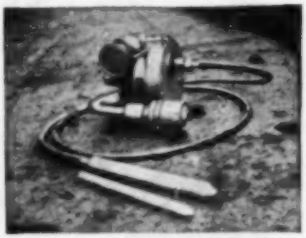
IN the construction of a concrete road in Kansas, U.S.A., construction joints 2 in. deep and $\frac{1}{4}$ in. wide are to be formed at intervals of 20 ft. Every fourth joint is to be formed by hand, but the others are to be cut by a power-driven saw between ten and twenty days after the concrete is placed.

The STRONGEST Concrete is JOHNSON Vibrated

Send us your Problems!

Please let us know your technical problems and allow our specialists to help you.

INTERNAL CONCRETE VIBRATORS
(Patented)
2 TYPES



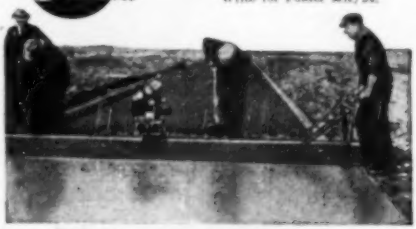
Extremely easy to work in close or intricate reinforcement. Petrol Flex Drive. Illus. Vibration is confined to the "spade," thus ensuring long life of motor; imposes no strain on operator; all mechanical parts greased and sealed for life. Also Electric Flex Drive and Electric Stiff Shaft models. Write for Folder V24.

QUICK to REPAY INITIAL OUTLAY

Continuous output
20/30 cu. yds. per day.
5/3½ CONCRETE MIXER
All gears totally enclosed.

JOHNSON "MIXRITE"

Mobile model "MIXRITE" Trailer type also available.
Write for Folder MX/24.



Perfect ROAD MAKING at SPEED & LOW COST. Perfect consolidation.

JOHNSON HAND SCREED
Standard Model (illus.) completes 130/150 cu. yds. or 900 sq. yds. of 6 in. "NO SLUMP" Concrete PER DAY. See Folder S/24.

C. H. JOHNSON (MACHINERY) LTD.
V/MX/S/24. **Adswood Road, STOCKPORT**

Write for details of our CONCRETE VIBRATING MACHINES Tables, Internal vibrators, Platform vibrators, etc.

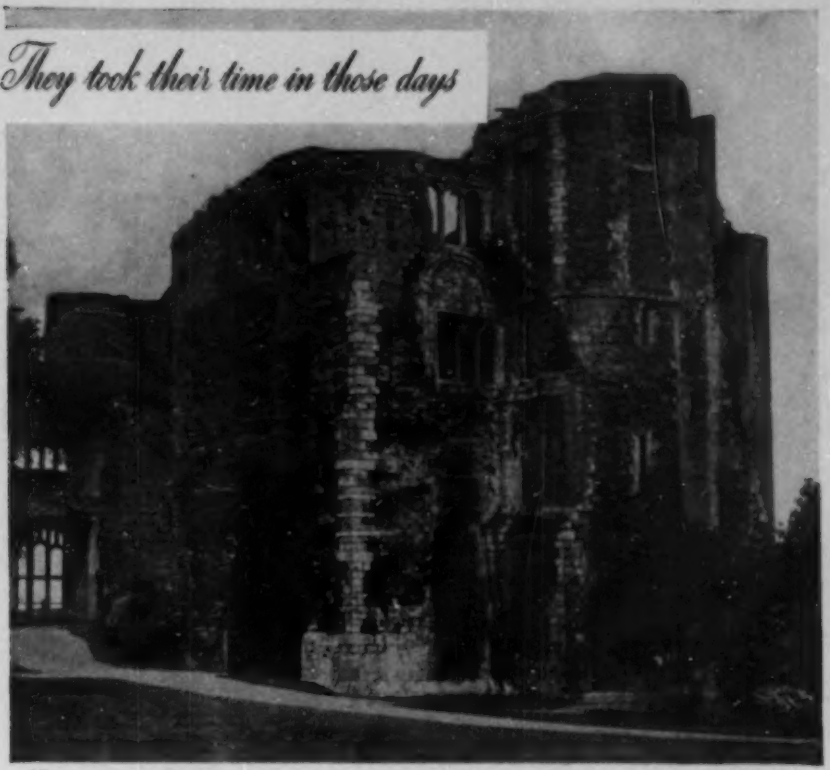
TERMS CAN BE ARRANGED.

For further details and full technical assistance, please telephone our nearest representative.

London: Pollards 1897. Bristol: Lulegate 277. Newcastle-on-Tyne: 23810. Yorks: Leeds 56165. Lancs.: Gatley 4404. Midlands: Sutton Coldfield, 2045.

589

They took their time in those days



27 *Newark Castle, Notts.*

...But when working against the clock use

'417 CEMENT'

QUICK SETTING
EXTRA RAPID-HARDENING

Full particulars of '417 Cement' will be sent on application to:—

THE CEMENT MARKETING COMPANY LIMITED
PORTLAND HOUSE · TOTHILL STREET · LONDON · SW1
G. & T. EARLE LTD · WILMINGTON · HULL
THE SOUTH WALES PORTLAND CEMENT & LIME CO. LTD · PENARTH · GLAM

Every
well-planned road
laid in
Reinforced Concrete
is a step nearer
to national
highway perfection

BRC

REINFORCEMENT FOR ROADS

THE BRITISH REINFORCED CONCRETE ENGINEERING CO. LTD., STAFFORD

London, Birmingham, Bristol, Leeds, Leicester, Manchester, Newcastle, Sheffield, Cardiff, Glasgow, Dublin, Belfast

M-W.598

Published by Concrete Publications Ltd., 14 Dartmouth Street, London S.W.1. Telephone: Whitehall 4581
Printed by Butler & Tanner Ltd., The Selwood Printing Works, Frome and London